Drawing out interaction:

Lines around shared space.

Claude P. R. Heath

Submitted in partial fulfillment of the requirements of the Degree of Doctor of Philosophy

School of Electronic Engineering and Computer Science
Queen Mary University of London

Despite advances in image, video, and motion capture technologies, human interactions are frequently represented as line drawings. Intuitively, drawings provide a useful way of filtering complex, dynamic sequences to produce concise representations of interaction. They also make it possible to represent phenomena such as topic spaces, that do not have a concrete physical manifestation. However, the processes involved in producing these drawings, the advantages and limitations of line drawings as representations, and the implications of drawing as an analytic method have not previously been investigated. This thesis explores the use of drawings to represent human interaction and is informed by the prior experience and abilities of the investigator as a practising visual artist. It begins by discussing the drawing process and how it has been used to capture human activities. Key drawing techniques are identified and tested against an excerpt from an interaction between architects. A series of new drawings are constructed to depict one scene from this interaction, highlighting the contrasts between each drawing technique and their impact on the way shared spaces are represented. A second series of original drawings are produced exploring new ways of representing these spaces, leading to a proposal for a field-based approach that combines gesture paths, fields, and human figures to create a richer analytic representation. A protocol for using this approach to analyse video in practice is developed and evaluated though a sequence of three participatory workshops for researchers in human interaction. The results suggest that the field based process of drawing facilitates the production of spatially enriched graphical representations of qualitative spaces. The thesis concludes that the use of drawing to explore non-metric approaches to shared interactional space, has implications for research in human interaction, interaction design, clinical psychology, anthropology, and discourse analysis, and will find form in new new approaches to contemporary artistic practice.

Declaration

I, Claude Heath, confirm that the research included within this thesis is my own work or that where it has been carried out in collaboration with, or supported by others, that this is duly acknowledged below and my contribution indicated. Previously published material is also acknowledged below.

I attest that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge break any UK law, infringe any third party's copyright or other Intellectual Property Right, or contain any confidential material.

I accept that the College has the right to use plagiarism detection software to check the electronic version of the thesis.

I confirm that this thesis has not been previously submitted for the award of a degree by this or any other university.

Signature: *Claude Heath*

Date: 20 December 2013.

Details of collaboration and publications: 'Making Space for Interaction: Architect's Design Dialogues' with Professor Patrick G.T. Healey, in, *Proceedings of the 9th International Gesture Workshop*, Athens, 2011.

Contents

List of Figures

List of Tables

Acknowledgements

This thesis is dedicated to my beloved father, Peter Heath, 1928-2013; and to all my family for their support, especially to Kulwinder, Arjun, and Kishan.

This work was supported by the Engineering and Physical Sciences Research Council (EPSRC). Thanks for support, advice and encouragement to Pat Healey, Graham White, Rose McCabe, Christine Howes, Columbine Gardair, Kavin Preethi Narasimhan, Saul Albert, Ruth Kempson, Trevor Marchand, Lizzie-Coles Kemp, Hannes Kater, and many others too numerous to mention here, including the participants of the drawing workshops.

Chapter 1

Introduction

Figure 9. The LSF sign PENSER À MILLE CHOSES EN MÊME TEMPS. Illustration Y.D.

Figure 1.1: **Delaporte and Shaw, 2009**.

Murphy's review of Steeck's book *Gesturecraft: The Manu-facture of Meaning*, outlines several issues related to drawing of interaction (Murphy, 2012). With regard to ethnographic research he suggests 'we should concentrate less on abstractly relating gestures to each other, and more on exploring the wider worlds that hands manipulate and through which they move.' The type of abstraction he refers to is seen in representational approaches that significantly rely upon the reader's ability to reconstruct interactional events from a combination of transcript, text, photographs, and drawings. In this approach, drawings are subordinated to a more general 'transcription technique.' Murphy's review is worth quoting at length:

> Line-drawings of human bodies, which have become common in texts on multimodal communication and which Streeck (or, probably more accurately, his publisher) uses in *Gesturecraft*, are severely constrained by a number of factors, including the quality of the drawing technique. There are many benefits to using line-drawings, like the cost of reproduction and the protection of participant anonymity, but the trade-off is a much lower level of representational fidelity than we get from screen-grabs and other photographic images, and this can result in transcripts that are diffcult to interpret. In this book's case, this transcription technique actually undermines a central component of Streeck's argument- that gestures are intimately connected to the material world - because in most of the examples the relevant portions of that material world are entirely left out of the image, and we're left to focus on the gesture and speech alone. This is partially compensated for by the inclusion of online video resources, but that solution is hardly sufficient, not to mention convenient.

1.1 Research Questions

1. Why is drawing still used in the social sciences, and why is it important to develop its techniques?

2. How is drawing used to describe and reflect upon the structure of shared space?

3. Can case-study interactions where non-metric behaviours and non-contiguous spaces are

demonstrated (Chapter. 3) be adequately represented using existing drawing conventions?

4. How does drawing facilitate speculative representations of these spaces, and do they lead to greater understanding?

The above questions are also addressed by chapters looking at the transferability of techniques for drawing shared spaces (Chapter. 5, 6):

1. Can **qualitatively structured** representations of interactional space be operationalised?

2. Do working-drawings made during these operations illustrate a **systematic development of visual inscription**?

3. Can drawings be said to test hypotheses about the structure of shared space against the empirical evidence of video?

1.2 *Gesture* image survey

A key preliminary question for this thesis is whether line-drawings are indeed commonly used in the literature on mutli-modal human interaction. In order to provide a snapshot of the state of the art, a survey of image-use in the journal *Gesture* was carried out. The aim was to find the ratios of photography to drawing use, and to observe whether and where this was in connection with gesture, interaction, or both. The survey was also directed towards gaining an initial overview of the full range of image-uses.

All issues of the journal *Gesture* between 2001-2012 were downloaded from the digital archive at UCL. All issues were inspected for their use of drawing and drawing composited with photographic stills. Drawings were 30.2 percent of the total number of visual representations of gesture and interaction.

The overall total number of photographs was 254, and of these just under half (110 photographs) were devoted to representing interactions. By comparison, there were 127 drawings

Mode of Representation	Specific Uses	Instances
Drawings	gestures	102
	interactions	25
	schematics	14
	subtotal	**141**
Photographs	gestures	144
	interactions	110
	subtotal	**254**
Composites of the above	gesture	15
	interaction	0
	subtotal	**15**
Moving image	general	**46**
sAnnotation software screen-shots	general	**12**
	Total	**468**

Table 1.1: ***Gesture*, 2001-2012, image-use survey.**
(Table. 1.1)

in these articles, only 25 of which were directly representing interactions, as opposed to individual gestures which may or may not have originated in an interactional context. Very often a single gesture is shown in drawings, often in sequence, without providing the surrounding context. These drawings are of one figure seen in relation to another, even if that second person is not actively attending, therefore making the relationship visible (rather than leaving this to the imagination of the reader). There is an easily overlooked but significant difference between a representation aimed at showing reciprocal interactions, and one that shows a segment of one person's gesture. The latter may be directed towards showing a selection of physical movements visually isolated from an overarching interactional context.

Movies (of which there were 46) could be classified belonging within the photographic category (they were accessible to some of the readers of the journal).

There were also sub-sets of representations of gestures, using techniques that cannot be categorised as either drawing or photography but are composite images. These are part-drawn and part photographic (numbering 15). Video annotation software screenshots also featured (numbering 12). These composites of drawing and photographic stills, or 'frame-grabs', were limited to representations of specific gestures without offering a broader context of interaction and shared space. The presence of a number of composites shows that there is a significant requirement felt by researchers, so that photographic material is enhanced by other means, in ways that maintain participant anonymity through drawing, for example, and in ways that could not be achieved by annotating upon and manipulating photographic data.

1.2.0.1 ***Discussion***

This image survey of *Gesture* does not take into account the overall number of papers and authors who have used drawings and photographs in their work, nor the distribution of these across the journal in terms of subject-matter, or temporally. The aim is to find the relative proportions of the modes of representations that are used and for what purposes.

On the basis of this survey of image use in *Gesture*, we can say that while photography dominates as a mode of representation, line drawing takes a significant secondary position. Whenever it is necessary to show the details of gesture, and of interaction, and to protect the identity of subjects, drawing is used to separate out and present the data that requires special attention.

Within drawings, most attention is given to representing gesture segments as discrete units of discourse, often in tandem with detailed transcripts. Rarely is an attempt made to visually represent the way in which these segments sit within the discourse as a whole. *Gesture* has most frequently shown the individual components of interaction, limiting the field of enquiry to this range. What might be called specifically qualitative representations, summing up the overall effect of gesture, are in marked absence. Exceptions are in the area of musical gesture (Rahaim, 2008), and comedic gesture (Poole, 2007). In this and the following section all references relate to *Gesture*.

The use of line and arrows in drawings of gestures and of interactions, have in this journal been restricted to representing vectors of movement and paths of vision. Occasionally a schematic drawing will make use of zones demarcating certain areas of space, but these are not related to any specific examples of qualities of interactional space.

1.2.0.2 ***The use of photography in 'Gesture'***

Figures that are photographs, including those that have been digitally adapted with simple arrows and lines. Some are composed of several photographic images as one figure. Others contain up to twelve separate drawings of dyadic interaction (Kimbara, 2006). Screenshots of video or software, have very often been adapted digitally by authors to depict movement vectors, adding arrows and lines. These practices are further discussed below (Chapter. 2, Appendix. D).

Photography of gestures include those where sign-language is posed for the camera, or is caught being demonstrated for an off-camera listener. A number of photographs and drawings are designed to complement movies that are contained in the electronic version of the journal. They are also intended to communicate essential content from the papers, to those readers without access to these movies.

If a photograph shows a solo person, and if this was captured as part of an ethnographic field survey with an explicit interest in interaction, this has been interpreted as a representation of interaction.

This category also includes photography of experimental situations designed to elicit interactional behaviour between participants, and where for example split screens are employed to show the relationships of these behaviours to each other.

Composites of photographs and drawings have often been designed to maintain the anonymity of subjects (Young, 2002). Some articles include both photos and drawings of gestures from the same interactions, which raises the question of why this was necessary. Existing documentation may not have been sufficient to the task, and drawings may have been used to replace poor quality photographs (Poggi, 2002). In other cases, drawings of gestures are included to supplement existing photographs by showing fine details of gesture paths and temporal ordering (Cardona, 2008). In a few cases drawing is the only way to show otherwise inaccessible detail of working diagrams of machinery being used by participants (Bolden, 2003). Preferences for the use of either drawing or photography are therefore guided by the requirements of particular contexts and research aims.

1.2.0.3 ***Drawings of interactions in 'Gesture'***

The majority of the drawings in the journal, as we would expect, have been specifically designed for publication. These include schematic diagrams, which have been included in this survey if they appear to be directly grounded upon empirical data observing gesture or interaction. They are often digitally produced drawings that have been abstracted from photographs or stills from video, sometimes rendered as if they have been drawn, perhaps to provide a sense of continuity with the line-drawing convention in use in the journal, and to increase the degree of abstraction for the purposes of bringing the attention of the reader to particular features of the interaction (Parrill and Sweetser, 2004). Some drawings of gestures are linked with photographs of objects used in interactions (Koschmann et al., 2007). In another case, small drawings are used in a table format to summarise the gesture typologies under study (Calbris, 2003).

Drawings of dyads or multiparty face-to-face interactions are very rare, notable exceptions to this norm are the drawings reproduced from medieval manuscripts (Dutsch, 2007). These show masked actors in the Roman theatre performing rhetorical gesture codes ('a little-known semiotic system') depicted as stylised figures with exaggerated hand sizes.

Other exceptions are similarly historic (Streeck, 2009). These relate to Saxonian manuscripts from the 1200's, showing embodied symbolic legal practice carried out through gesture, where there was a legal requirement to make the transaction visible to those present. These drawings show the same figures more than once within a sequence, and act as 'discursive registers' of the proceedings. These are 'highly legible text-image combinations', showing a series of transactions in time, but also four layers of feudal hierarchical relationships.

Published drawings in *Gesture* borrow substantially from art traditions that are sometimes beyond the Western canon, such as Manga graphics (Chui, 2012), and also invoke a culturally distinct spatial order (Rahaim, 2008).

1.2.0.4 ***'Gesture' image-survey summary***

The survey of *Gesture* shows the usages of drawings of gesture and interaction in a scholarly context. It shows that nearly one third of all representations in the journal are drawings, and that they are adapted for use in a wide range of contexts, to depict gesture, and also multiparty interactions, in detail, and in schema. As the following chapters will show, the processes involved in producing these drawings, the advantages and limitations of line drawings as representations, and the implications of drawing as an analytic method have not previously been investigated.

1.3 Research position.

This thesis will approach the following research questions via a two-pronged investigation of the theoretical issues and a sustained practice of drawing from video data. These activities have run in parallel and have overlapped to great extent, and has been informed by the experience of the investigator as a visual artist, developing an array of drawing techniques and aptitudes over an extended period of time (Heath and Taylor, 1999, Kingston et al., 2003, Bee and Heinzelmann, 2004, Patrizio and Kemp, 2006, Heath et al., 2008, Heath, 2011, Maslen and Southern, 2011).

Two phases of research:

1. The first constructivist phase, where exploratory drawings looked for new approaches to representing shared spaces, seeking differentiation from the types of drawing that have gone before.

2. The second quasi-participatory phase, building upon the first, consisting of the drawing workshops
(Chapter. 6).

At both stages, a largely inductive analysis was carried out in relation to case-based evidence (Thomas, 2003). A constructivist approach is used throughout. The discussion of existing drawings and techniques, and the assessment of new approaches in the face of newly identified requirements naturally invokes typical constructivist criteria such as credibility, usefulness, resonance, and transferability, amongst others that are specifically visual. 'Constructivists enter the phenomenon, obtain multiple views of it, and then locate it in its web of connections and constraints' (Charmaz, 2006, p.187, see Glossary. A.0.2.8). This immersion in case-study and workshops data, as well as the prevalent conventions surrounding data representation, serves to ground the analytic process and the analytic categories that are also being investigated.

Of the several research paradigms that are available to researchers (Denzin and Lincoln, 2005), no single one is especially suited to the aims of this particular thesis. This thesis therefore demonstrates a mixed research design (Creswell, 2013). A method of enquiry is said to be 'a bundle of skills, assumptions, and practices' (Denzin and Lincoln, 2005, p.14), and qualitative research in particular can involve the application and management of a large range of manual and other research techniques (p.11). This includes the several different but related drawing practices that were used in this thesis. The merging of methods across these two phases is designed to be a 'complementary' relationship (Tashakkori and Teddlie, 2010). The broader first phase of research identifies one drawing technique which is then rolled out to test closely related research questions with the cooperation and participation of a small focus group of researchers.

The methods used in the two research phases thus echo each other structurally, in their use of drawing upon similar subject matter in each case.

The present author is biographically situated as a researcher by having a previous and continuing history as an exhibiting artist, entering the research community and constructing an interpretive perspective upon the material. This constructed view has emerged as the investigator's familiarity with the field has developed. More commonly, researchers enter the research process from inside an 'interpretive community' and already have a degree of knowledge about its customs and interests. The present approach is a gradual refining of research methods and paradigms, with the aim of hitting the target problem. This is a type of scenario familiar within the creative arts, where projects evolve in an organic fashion around their constraints. In particular, the experience of the author as an artist is suited the development of a research design that involves specific 'inscription devices', for the purposes of testing new approaches to representing shared spaces (Fig. 1.21). However, it is not assumed that similar 'devices' should be used by other researchers, instead this is seen as a means to iteratively refine research questions and results, in a context where the insights produced by one drawing leads to an investigative imperative to carry out the next.

Contemporary art drawing practices that involve drawing from the moving image will be discussed below (Sect. 1.7). This reveals that drawings relating to interaction tend towards being relatively undifferentiated knots of gesture or movement vectors. In the light of this and the survey of the field in the following chapter it is possible to identify more clearly the innovations of the later drawn explorations of this thesis.

1.4 Drawing as method.

Why is drawing still one of the most commonly used methods for capturing and representing human movements in space and time? What does the process of drawing provide to analysts that observation alone, video, photographs and digital images do not? In order to answer these

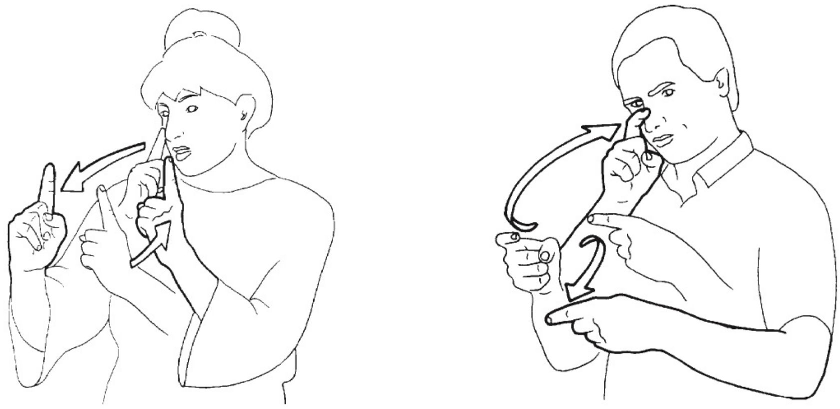


Figure 15. Contemporary LSF signs ERREUR (left) and AVOIR TORT (right). ©IVT.

Figure 1.2: **Delaporte and Shaw, 2009**

questions it is useful to consider the history of drawing as an analytic tool and the contrast with, actual and counterfactual, uses of video.

In view of the prominence given to drawing in the research questions outlined above, it is necessary to examine in more detail how drawing can act both as a research tool and as a research outcome. What additional information can drawing hope to bring to our attention about these interactions, and how will it do this? What is it that it is possible achieve with drawing which cannot be done by watching ethnographic video material and saving screenshots? In which ways it is possible that the act of drawing offers us something indispensable and different from studying video closely?

According to gesture researcher Adam Kendon, drawing is a quickly performed and readily available method to bring the attention of the reader towards those aspects of the interaction that are of special interest and relevance to the analysis provided in writing (Kendon, 2004). Drawings show the reader how the interpretation of the data is visualised, since they have been designed (on the researcher's own terms) to impart a particular inferable meaning.

Drawing and formalised video notation cannot be equated with one another (see Sect. 7.3.1), but there are some analogies to be drawn between the two processes. According to McNeill's collaborator and coauthor Susan Duncan, specially designated notations are 'convenient handles,' 'designed to further one's target analysis' (McNeill, 2005, Pass 6, Section E.1, unpaginated appendix). Hypotheses, she states, should be typed into the transcript as a matter of course, so that this analysis can be reconstructed by any following researcher. In the grey area of those instances where data is unclear or the evidence is incomplete, the 'inferable meaning' of the gesture is to be recorded. At the same time she claims that 'no transcription system is simultaneously detailed enough and transparent enough to substitute for images in a scholarly article' (Sweetser and Sizemore, 2008, p.207).

Is it possible that the act of drawing can change the possible interpretation of the subject? Working with drawing affords us the opportunity to document how the physical use of materials can overlap with the development of ideas, and so to begin to answer this question.

1.4.1 Drawing as analysis: storms, hearts, and nerves.

Historically, drawing has often been characterised as a process of exploration, bringing together concepts from these domains and refining them. Leonardo da Vinci is often cited in this regard, whose studies of water and clouds for example, led to an understanding of them as a class of 'bodies without surfaces' (Da Vinci and MacCurdy, 1957, see Fig.1.4). Clouds have no precise boundaries and interpenetrate with others (Damisch, 2002, p.124). Leonardo also called for human anatomy to be observed accurately, and cautioned against the exaggerated musculature of Michelangelo's figures, referring to them as 'bags of nuts' (Fig.1.3). His aim was an improvement in the portrayal of expressive posture and gesture in painting, and his drawings of the elements were responses to interactions he observed in nature.

Leonardo's drawings of the anatomy of the human heart are paradigmatic of scientific and artistic observation. According to a contemporary heart surgeon (Frances Wells, Consultant Cardiothoracic Surgeon, Papworth Hospital, Cambridge), they have not been excelled since the time of their making (Peto, 2007). The drawings contain minutely observed structures in the closure mechanism of the tricuspid valves of the heart, especially the complex shapes of

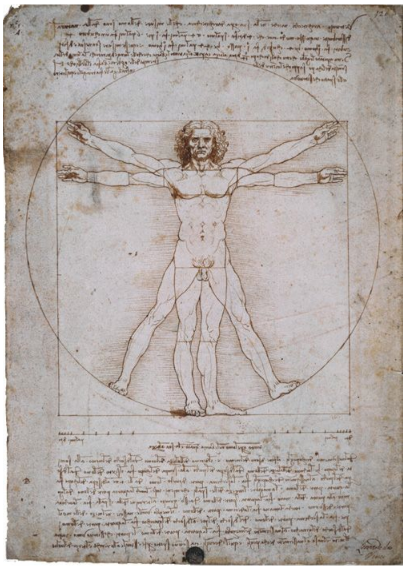


Figure 1.3: **Leonardo da Vinci.** 'Vitruvian man' pen and brown ink with wash over metalpoint, 34.4 x 24.5 cms. Galleria dellAccademia, Venice.

the pulmonary and aortic chambers above them (Fig.1.5). Leonardo was able to bring to this problem his own knowledge of mechanics, engineering, and hydrodynamic theory (as exhibited in his studies of cloud formations and storms). Leonardo's observations, according to Wells, were directed by his asking questions about the function of a mechanism that was not understood, speculating and testing through the process of drawing. The observational process evolved in parallel with the formation of new concepts.

Techniques in contemporary drawing research are many and varied, and are often subordinated to the questions that they set out to investigate. The distinctions between paper and newer digital media become blurred through practice, and traditional approaches are gradually replaced by an expanded concept of what drawing can be.

Historically, when a technique is newly invented, the boundaries between media are realigned and the possibilities for creativity expand. At its inception, photography was linked with drawing (Bermingham, 2000). The inventor of photogaphy, Henry Fox Talbot, referred to

Figure 1.4: **Leonardo da Vinci**, 1518. 'Hurricane over horsemen and trees'. The Royal Collection Windsor.

these first images as 'photogenic drawings', which are today called 'photograms.' He referred to photography as 'The Pencil of Nature' (Talbot and Schaaf, 1969). He also describes how his use of the *camera lucida* and the *camera obscura* 'led me to reflect on the inimitable beauty of the pictures of nature's painting which the glass lens of the Camera throws upon the paper.' The *camera lucida* was a traditional tool from painting and drawing, in use since 1807, and was at this time at the heart of a technological transformation (Appendix. A.0.2.6).

Drawing has had a significant and well documented role in the history of science, when it is brought to bear upon intractable subject matter. Cajal, the originator of the concept of neural networks, employed older technology (*camera lucida*) alongside the modern microscope, moving between these for different purposes, and claiming that freehand drawing was the optimal procedure (Cajal, 1910, see Fig. 1.6). The former was useful when outlining the profiles and the relationships of the nerve cells. 'He later filled in the details by hand, especially in large regions of brain that could not readily be retained in a single field of view' (Garcia-Lopez et al., 2010).

Drawings made with this unusual combination of techniques continue to be made in contemporary neuroscience, as an essential bridge between observable structure and known function.

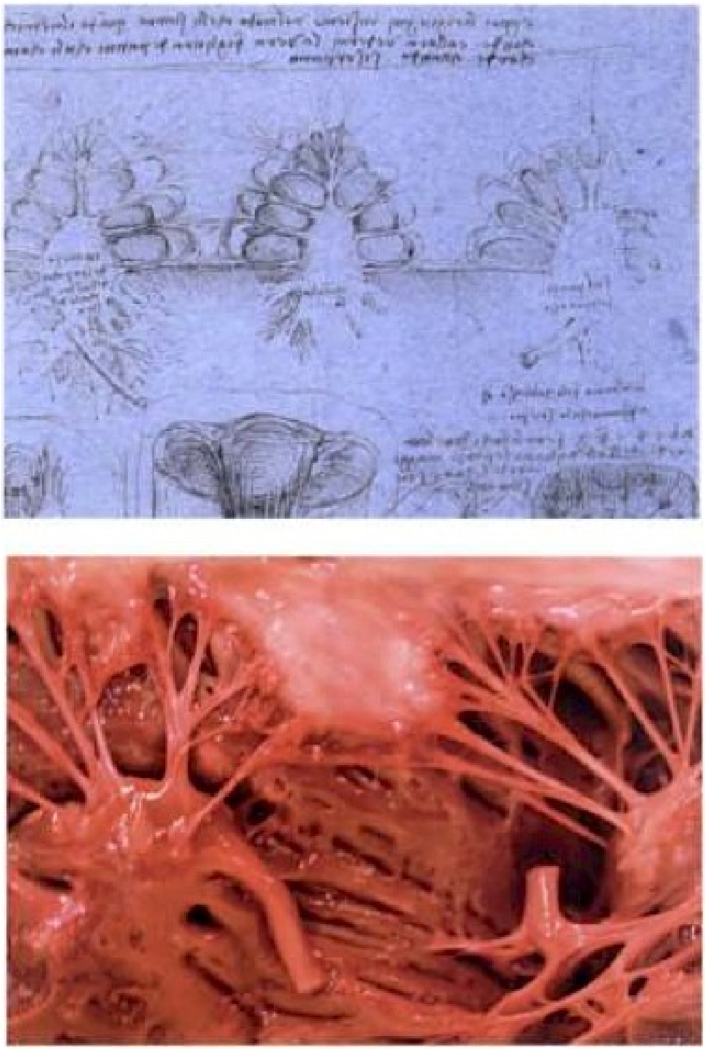


Figure 1.5: **Leonardo da Vinci** Above, Leonardo da Vinci, drawing of the tricuspid valves of the heart, date unknown, and below, photograph of the tricuspid valves of the ox heart. From Wells, 2007.

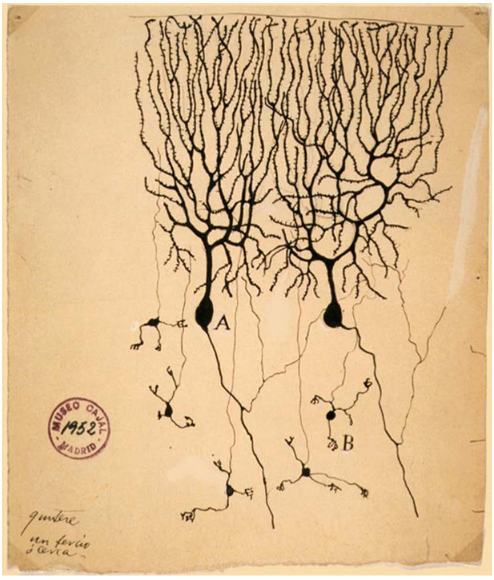


Figure 1.6: **Cajal, 1899.** Drawing of Purkinje cells and granule cells from pigeon cerebellum. Instituto Santiago Ramón y Cajal, Madrid, Spain.

For example, drawings related to the dynamics as well as the three-dimensional structure of the cells. Dynamics include 'action potentials' and chemical interactions. According to Wolfgang Grunewald, 'the drawing emerges during a 'camera movement' or 'dive' through the brain' (Berg et al., 2004, p.113). The 'fine, widely out-branching nerve cells cannot be represented in their totality without schematising them. A spider web one hundred metres square cannot be realistically drawn when seen from a distance of 10 metres.'

1.5 Drawing and qualitative space.

For thousands of years drawing, mapping, diagramming, and visual notation have transmitted knowledge and culture. Line drawing has been singled out as a particularly salient form of communication (Craig-Martin and Martin, 1995, and Ingold, 2007). Over this time a wide range of 'drawing systems' have been evolved through the practice of perspective drawing, for example, each of which has its own rationale, method, and object of enquiry (Dubery and Willats, 1972). It is not surprising therefore that artists have become living repositories of expertise in the practice of drawing systems of all kinds, and as such have become a valued resource (Kozbelt, 2001). Reasoning in visual cognition can be examined in the ways that drawings are constructed (Van Sommers, 1984), and the ways in which these are spoken of and acted upon (Heath et al., 2008). Added to this, diagramming and drawing have become standard tools in the repertoire of participatory action research (Chambers et al., 1997) applied in diversely situated engagements (Theron et al., 2011).

1.5.1 The notation of dance

Drawing has been employed wherever the aim is to record and preserve the visual phenomena of human interaction, whether to aid the transmission of a cultural form, or to devise a means of notating and analysing this. Dance notations are not strictly comparable to the notation of human interaction, but there are some potentially useful if indirect lessons to be learned from their approaches and structures (For more on notational language see Sect. 7.3.1). Dance is an example of an art form that requires transmission via a notation for it to be passed on to new dance companies without relying solely on memory and perhaps filmed recordings.

Two contrasting approaches to documenting choreographed dance movements are outlined here. First, *Labanotation* is one of the formal graphical notations for dance, with a strong visual component in the organisation of its symbolic language along 'staffs' for each performer. The term 'gesture' in this context concerns larger bodily movement more than movements of the hands. Gesture in dance is intentionally choreographed to convey effects and thematic 'topics', so it is perhaps instructive to see the layout of a notation that accomplishes this.

The seminal 1932 dance work *The Green Table: a dance of death in eight scenes* by Kurt Jooss, demands relatively precise hand movements (Fig. 1.7). The dance title is a reference to the futility of peace negotiations between nations at the end of the first world war. Dancers move around and use the surface of a long green baize table to serio-comical effect, their movements heightened with white gloves. The dance has been scored with *Labanotation*, including a note at the top, 'a and b point to the same spot on the table' (Markard and Guest, 2003, see Fig. 1.8).

Figure 1.7: **Kurt Jooss, 1932, 'The Green Table'**. Note that the dancers are required to point at a region on the table.

The score contains detailed instructions regarding hand position, but this 'spot' is not clearly marked on the small time-series of overhead views below. There is no need for exactitude of this kind, because the disputed maps are not physically but only symbolically present to the dancers and audience.

In 2008 choreographer William Forsythe collaborated with researcher at Ohio State University, to produce and notate a dance-work, *Synchronous Objects: One Flat Thing, reproduced*. Dancers move among a dense rectilinear array of tables, improvising their actions to a prescribed degree and interacting with each other via predesigned and improvised cues. The aim of the project was to devise a new visual notational approach to dance movement, and to develop an alternative theoretical view of the issues involved in this (Forsythe, 2008). An interactive website was designed to document an extended period of experimentation by a team of animators and researchers.[1]

[1] www.synchronousobjects.osu.edu/

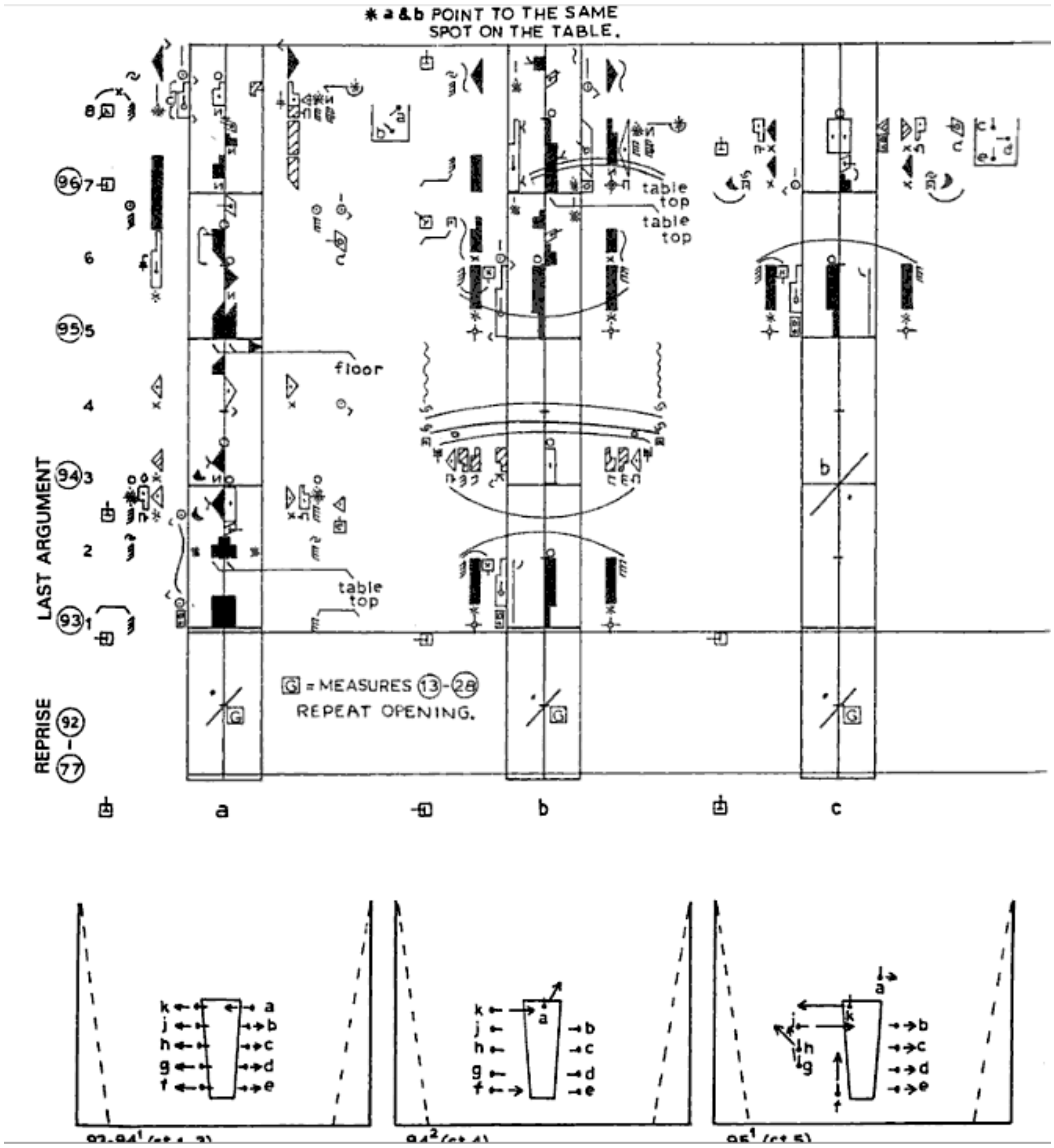


Figure 1.8: **Markard and Guest, 2003.** An excerpt from the *Labanotation* score for 'The Green Table'. Note at the top the direction: 'a and b point at the same spot on the table.'

The goal was to design a notation for the alignments and synchronies of the dancers, and to animate this with graphic elements superimposed onto the video. Two cameras were used, one above, and another showing the audience's view (Fig. 1.9, and 1.10). These results are also visible without the video. While looking at the recording of the dance, notations were placed along the time-line 'when we felt that we saw a relationship' between the movements of the dancers, according to project designer Maria Palazzi. The two views of the scene were used to create a three-dimensional surface between points, tracing multi-dimensional animated 'action lines.' These then stood for those observed relationships as notations superimposed upon the video. The researchers noted that the cueing between the dancers is easier to follow in plan view, but easier to determine initially in the frontal view. Gaze was not included in the final output because it was felt that attempts at showing gaze via sight-lines, or 'beams of light', that 'didn't really feel connected to the dancers' and did not 'have a life of their own' said Mary Twohig, of the project team.

The animators became interested in fading the inscriptions at different rates, with the interactivity of the public website giving control of the degree of apparent 'accumulation in the space.' The designers intended to privilege the dancer's perspective rather than the choreographer's (who related their experiences of how they 'feel' their way through the dance). The scoring of the piece is a method for inscribing specific spaces, or connections between them, interpreting and subsequently providing an interactive view of the shared qualitative spaces that are founded throughout the dance. None of these facilities would be available in *Labanotation*, which is not directed at recording qualitative data.

The sketch-like style of the *Synchronous Objects* notation is integral to their ability to represent the dynamics of dancer interactions, especially in connection with identifying synchronies in visual terms, and revealing the patterns of danced improvisation brought about by cueing practices in shared performance spaces. There is a lively calligraphic aspect to these notations, especially when they are viewed on their own, without the background video of bodily move-

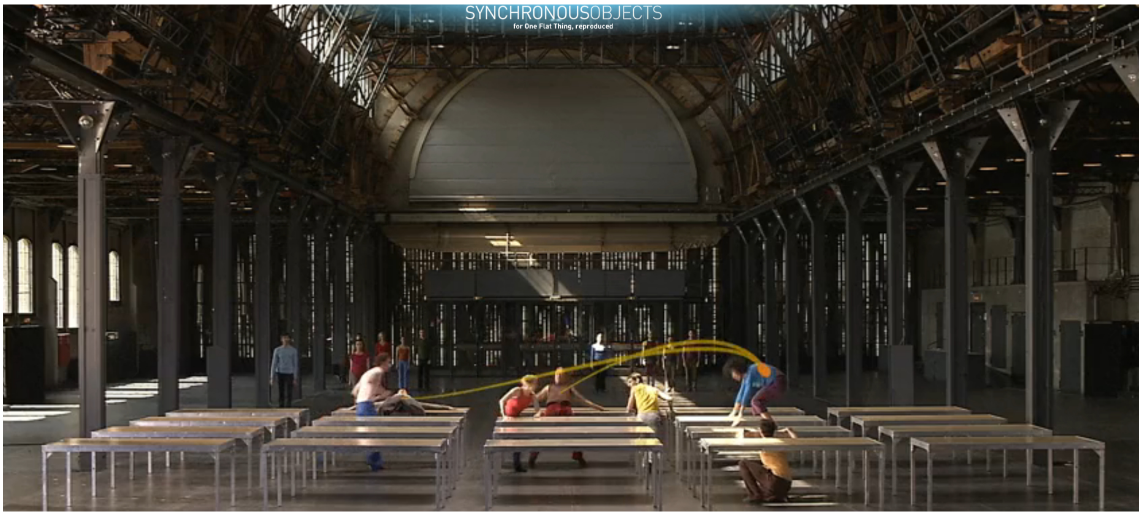


Figure 1.9: **'Synchronous Objects: One Flat Thing, reproduced.'** Choreographed by William Forsythe, 2008. Image courtesy of Ohio State University and The Forsythe Company.

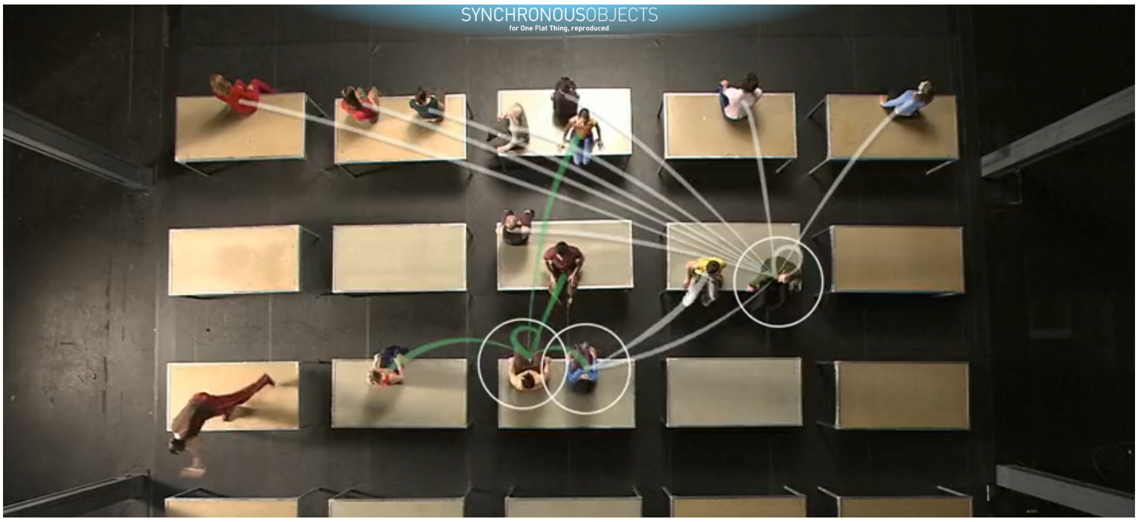


Figure 1.10: **'Synchronous Objects: One Flat Thing, reproduced.'** Top view. Choreographed by William Forsythe, 2008. Image courtesy of Ohio State University and The Forsythe Company.

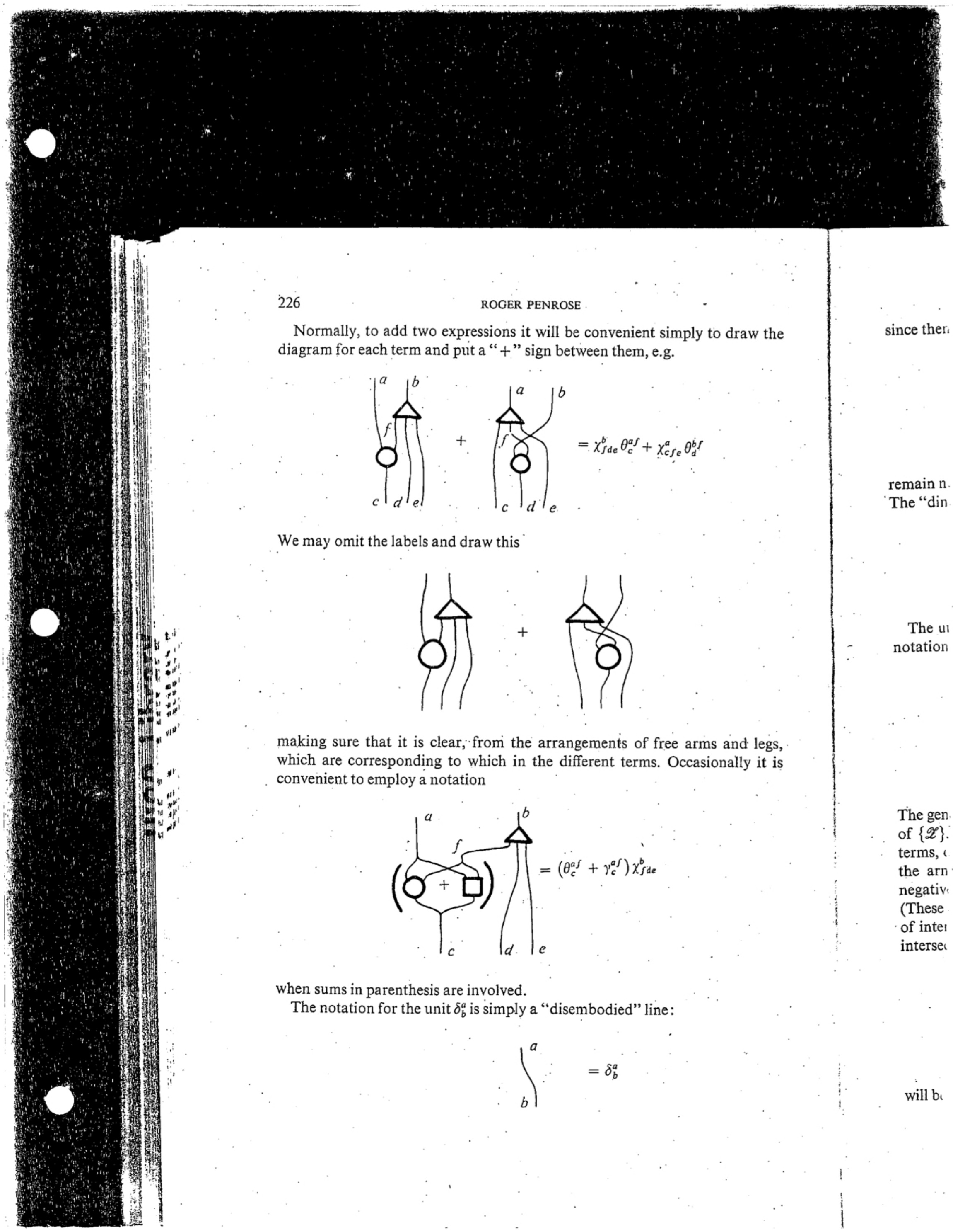
ments. The ‘marks’ appear to fold over themselves and into one another, and have upper and lower edges. The twisting and knotting of this ribbon gives a strong impression of fluidity, connection, and space that has been turned through.

These examples illustrate how formalised visual notations that have been developed for characterising movement in dance, tend to focus on a limited number of selected movements and their trajectories. This is due to their intended role as instructions to be followed by choreographers and dancers. As we shall see in Chapter 4, this becomes insufficient where we need to represent distinguished qualitative spaces or regions in ordinary interaction that do not correspond in any direct way to particular physical movements. The specialised vocabulary of the abstracted score is a barrier to general consumption, demanding a special kind of literacy and familiarity with dance practices. Background knowledge and expertise allows a dynamic multi-dimensional event be recovered from a two-dimensional notation and line drawing.

1.6 Visual observation and reasoning

Forsythe’s dancers are circled and inter-linked by animated linear notations. If, for the sake of argument, the the plan-view video channel is hidden, and we saw only static inscriptions, we might conclude that these were graphical mathematical notations. Diagrammatic reasoning methods have indeed been devised in order to represent and manipulate the terms of complex non-linear events and space-time fields (Penrose and Jorgensen, 2006). Mathematical physics sometimes conducts its reasoning with such diagrams, ‘Quantum measurements without sums’, in ways that are apparently accessible to non-mathematicians (Coecke and Pavlovic, 2006). Contrasted states of affairs are occasionally written about in metaphorical terms, sometimes as specific ‘arrangements of free arms and legs’ (Penrose, 1971, p. 226, see Fig. 1.11).

Mathematical graduate students speak of feeling physically imbued into the graphs of mathematical functions, at particular locations within them, and advancing their understanding of them as a result. They report that ‘you kind of feel like part of the graph, going up and down’



226 ROGER PENROSE

Normally, to add two expressions it will be convenient simply to draw the diagram for each term and put a "+" sign between them, e.g.

$$= \chi^b_{fde}\theta^{af}_c + \chi^a_{cfe}\theta^{bf}_d$$

We may omit the labels and draw this

making sure that it is clear, from the arrangements of free arms and legs, which are corresponding to which in the different terms. Occasionally it is convenient to employ a notation

$$= (\theta^{af}_c + \gamma^{af}_c)\chi^b_{fde}$$

when sums in parenthesis are involved.

The notation for the unit δ^a_b is simply a "disembodied" line:

$$= \delta^a_b$$

Figure 1.11: **Roger Penrose, 1971.** 'Applications of negative dimensional tensors', p.226. Note the deliberate omission of labels on the second hand-drawn formula.

(Gerofsky, 2010, p.336). This is summarised as 'seeing the graph' versus 'being the graph (p.331). There is no doubt that the compression of dense formulaic representations into simplified graphic terms facilities the advancement of thought, where each pass of diagramming and drawing increases the rigour of each cycle of development (Goresky and MacPherson, 1988).

To read this thesis does not require the mastering of a notation. There is no direct comparison to be made between formal mathematical thinking and the informal and speculative restructuring of qualitative space. The aim here is to stimulate the human interaction researcher to arrive at their own criteria with which to manage the visual and qualitative complexities of interaction. Line-drawings of the type that are found in the journal *Gesture* are essentially collections of techniques for recording observations that have come about as a result of looking at the data with specific criteria in mind. The only comparison to be made between drawings of human interaction and formal reasoning with abstract notations, is that in both cases there is a visually structured argumentation increasing in perspicuity with each pass.

The preceding examples have highlighted how drawings that are made by hand from first-hand observation seem to change our perception of how space is organised, doing so by bringing a manual component to the process of organising these spaces. The accuracy of the observational process entails a constant checking of inscriptions against the data. In drawing practice this has been described as the requirement to 'look little and often' (Cohen, 2005). Working drawings often contain 'mistakes', errors, and mis-steps, as well as corrections, and they therefore reveal a great deal about how analysis and understanding develops (Van Sommers, 1984). The purposes of drawing are at least two-fold, first as a method of analysis in itself, and following this, as a means of representing or illustrating the results of observation for wider consumption. Implicit in this is the fact that the manual process of drawing has an ability to formulate understandings that emerge through and because of the physicality of the process.

1.7 Artists drawings and the moving image

While much recent and contemporary visual art has represented human movement and human interaction in one way or another, there are a number of art practices that have focused on the use of drawing to provoke questions about how interaction is to be visually understood, and how it can be presented. These involve highly individual inscription practices and inscription devices developed over long periods of time, through which the artist finds and gradually uncovers their subject. In some cases artists produce drawings as part of an interest in animation, and in other cases they produce sparse line drawings that have some similarity to those found in the social sciences.

Drawing need not be limited to the sheet of paper. Robert Breer's part-drawn and part-filmed animation of 1974 begins with hand-held coarse grained filmed footage of passengers on a train carriage as they journey past Mount Fuji in Japan. Dozens of drawings create a flickering sequence of repeating and interleaving episodes from the railway trip, creating the impression of a moving palimpsest, qualitative experience somehow blended with recognisable photographic imagery (de Bruyn, 2007, see Fig. 1.12). Breer was, most probably, referencing Hokusai's '100 views of Mount Fuji', a book of woodblock prints showing the mountain from 100 viewpoints, with contrasting human activity in the foreground (Katsushika and Smith, 1988), and Cezanne's extended series of drawings and paintings in and around Mont Saint-Victoire in southern France (Boehm and Cezanne, 1988).

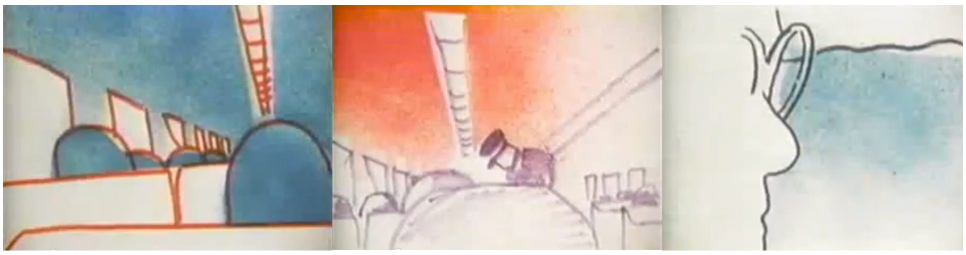


Figure 1.12: **Robert Breer, 1974.** *Fuji (1974)*, animation. Selection of stills. An excerpt is available at http://www.youtube.com/watch?v=HudkC6Oapww, accessed 6 September 2013.

In 1995 Rachel Lowe made rapid drawings of passing scenery directly onto the windows inside a passenger train carriage (Bee and Heinzelmann, 2004). The artwork in its public form consists of a single-copy 16mm analogue film of the drawing event, shot with the artist"s drawing hand in view and a blurred landscape behind. The frantic attempts to match the speed of the drawing to the speed of the train would seem to underline the futility of even trying to capture a fleeting reality in this way but the end result is a drawing that both follows and contains movement of different kinds (Fig. 1.13, and 1.14). By calling this series of works *'A Letter to an Unknown Person'* Lowe makes a connection between this type of rapid drawing and writing or shorthand. Later work accomplished something similar by drawing onto the glass screen of a television monitor replaying Grand Prix racing, and attempting to draw the same cars on the same bends of the track. Once again, the resulting artwork is the film of this rather than the drawings on the glass themselves.

Cinema provides artist Pierre Bismuth with the raw material for inscriptions of specific moments that particularly affect him, the drawing lasting for as long as he does not become disengaged from the performance of the actress. This can be at any point during the film, whether near the end or beginning, making denser or thinner masses of linear trace marks. This series of works are entitled *'Following the right hand...'*. For example, a drawing made in 2004 is titled *'Following the Right hand of Marlene Dietrich in Blonde Venus (1st version) After Joseph Von Sternberg 1932'* (Bee and Heinzelmann, 2004). For these drawings marks are made on perspex placed over the screen that is showing the film, which can then be displayed on its own, or with a still from the film mounted behind the framed drawing (Fig. 1.15).

Bismuth also appropriates footage that he has found in documentary films. For example, *'Following the right hand of Freud'*, documents a minimal series of hand gestures followed with line and filmed on 16mm and transferred to digital form (the later being a step that Lowe did not wish to take). Later, Bismuth made ink on paper drawings based upon this same footage of Freud which bear a resemblance to the 'automatic drawings' of the surrealist movement (Fig. 1.17).

Figure 1.13: **Rachel Lowe, 1998.** *Letter to an Unknown Person No.3.*

Figure 1.14: **Rachel Lowe, 1998.** *Letter to an Unknown Person No.5*

Sigmund Freud being the subject adds a new conceptual dimension, turning the analytic methods back onto its creators. Unlike Lowe, Bismuth tracks only one part of the subject, the right hand, perhaps because it is associated with the ‘conscious’ mind, but nevertheless occasionally the drawn marks very nearly overwhelm the photographic image underneath.

Shared public space in art has been referred to theoretically as ‘pedestrian space’, in relation to artwork that minimally intervenes in gallery space, for example, in such a way to makes people move in a slightly different way though them (Sandback et al., 2005). There are also examples of art practice that are interested in following movement through public space, using drawing to record patterns of movement or configurations of people in context. Morgan O‘Hara isolates movement from its context, leaving only a trace of how pedestrian space is being used. She draws the movements of people as they go about their business, playing music, performing dance, or circulating around the stalls of a fish market (Zahrádka, 2011, see Fig. 1.18). The physical context is absent, and only suggested in the drawings by being a limiting factor upon

Figure 1.15: **Pierre Bismuth, 2004.** *'Following the Right Hand of Ingrid Bergman, in Intermezzo.'*

Figure 1.16: **Pierre Bismuth, 2013.** Two stills from *'Following the Right Hand of Sigmund Freud.'* 16 mm film transferred to DVD, duration 01:30 min, 2013.

Figure 1.17: **Pierre Bismuth, 2013.** *'Following the right hand of Freud'*, black ink on japan paper, 64 x 96.5 cms.

the lines, so where the marks gather together, we can assume that people's movement are an expression of their interest in specific places, people, and objects, in this case, a popular fish stall. As with Bismuth and Lowe, the criteria being used to construct the drawings, which parts of the scene to follow and when, are slightly mysterious but none the less effective at summoning up the presences and absences of social practices (Giddens, 1984).

Physical movement in and around 'pedestrian space' is a strategy used in contemporary art drawing practices where photography and film is eschewed. Configurations of interaction in context are examined in the work of Alexander Roob, as resident artist at 'The Guardian' newspaper or 'Deutsche Boerse' head-quarters, for instance. He works in a peripatetic way, drawing with pencil in a small sketchbook, recording social interactions and their environment in a dispassionate manner as he moves around a location (Kingston, 2001). Roob's art is presented in book form, and as long horizontal sequences on purpose-built shelves for the gallery viewer. The notion of 'reportage' is important to him, suggesting that he is unavoidably part of the picture by being present at the time of its making, as he shifts vantage point according to what is going on around him just as a photojournalist would (Fig. 1.19). Unlike Lowe and Bismuth,

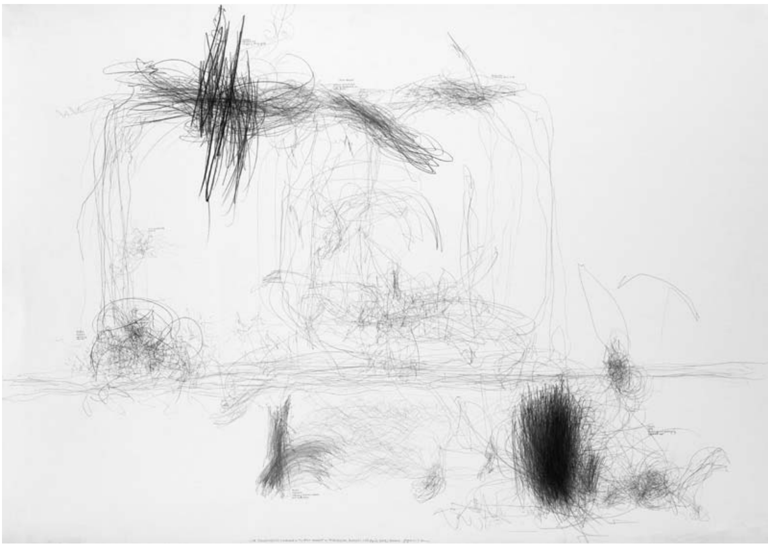


Figure 1.18: **Morgan O'Hara, 2003.** *'Movements of vendors and labourers, Furukawa Fish Market, Aomori, Japan'*. 76 x 106 cms. Pencil on paper.

Roob has not experimented with animation or the combination of drawing and photographic imagery. Here drawing is able to attain a different type of faithfulness to and involvement with the subject not available to photography.

Notation at some point merges into drawing, and this is explored by artists who are interested in inhabiting the region between art and symbolic representation. Hannes Kater makes commissioned drawings from textual briefs sent to him, retaining the original drawing but providing a scanned version at no cost. Kater continuously evolves his system in order to describe any set of circumstances that he is presented with, using a range of idiosyncratic iconographic symbols which calls 'Performers', including qualifiers, arrows of different kinds, and numbering of sequential events. 'Active' red symbols describe the architects conversation as constructive or positive, while 'negative' blue relates to the figure at the lower right corner. This is the Protagonist or 'Client', the observer of the architect's conversation. Below this figure is a field, or grid, that refers to 'the sphere of meaning', plotting changes to its structure.

Kater was asked represent the data extract that is discussed in later chapters of this thesis

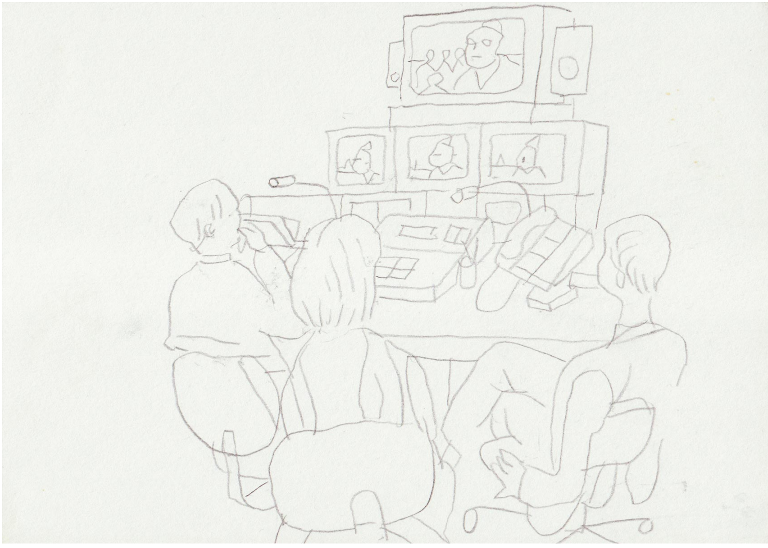


Figure 1.19: **Alexander Roob, 2003.** *'Deutsche Boerse'.*

(Chap. 3). He does not use arrows to represent pointing movements, but as metaphors for the flow of ideas, passing between people, and consequently emerging from a chain of acts by more than one person. In its inventiveness and very different approach, in comparison to the literature examined (Chapter. 2), Kater's drawing benefits from a two-fold freedom from human interaction theory and from transcriptions of speech (Fig. 1.20). He stated that this drawing was one of the most difficult he had been asked to make.

The artist's drawings described above are constructed according to selections from a larger pool of information and perceptions, and might be based upon following specific parts of bodies through space and time, or upon certain movements, or the flow of communication. However, beyond this selection, the representations are not structured any further, and the lines that constitute the representations have a tendency to quickly build up to a degree where it is difficult to untangle element from element. Moreover, they deliberately layer temporal and spatial shifts into one image so that any two lines may have very different contexts and sources, for example where the camera position, setting, and the motions of actors are all subject to frequent and rapid change.

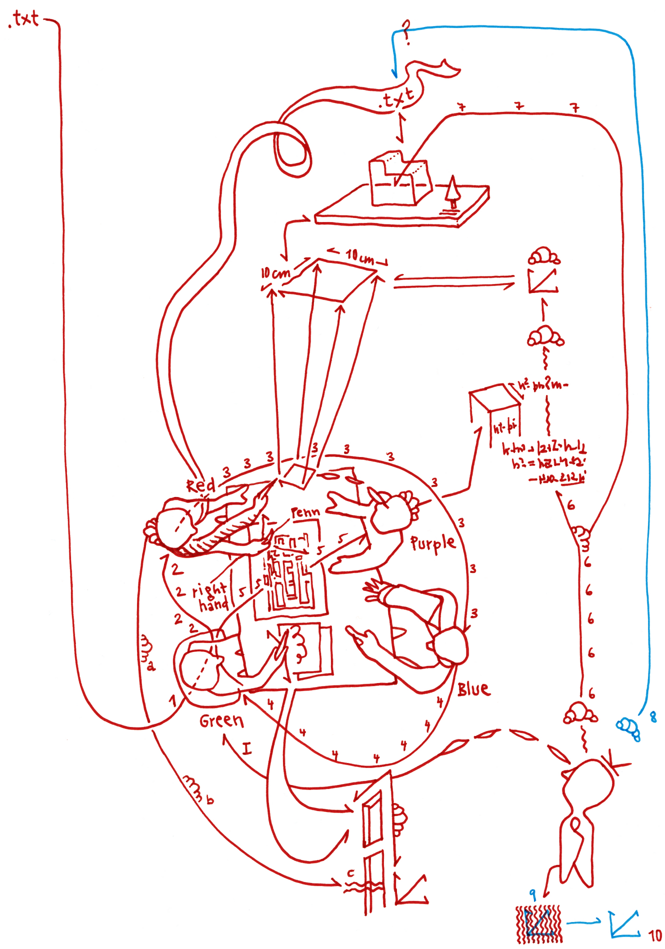


Figure 1.20: **Hannes Kater, 2009.** Ink on paper. A commissioned drawing representing the data extract that is discussed in later chapters of this thesis, Clip 1. ‘Red’ is architect ‘B’, whose hand makes a gesture in the air, contributing to the finalisation of the group’s joint conceptualisation.

Despite these limitations, the form of these artists representations, and the ways in which they have been gathered from life and film, serve as a useful backdrop to the drawings made for this thesis. They point to important differences in the ways that the present exploratory drawings have been structured and gathered from film. In this way we can say that contemporary drawing informs the general outlook of this thesis and have helped to set the scene for the present work by establishing precedents for working from moving images with drawing, and pulling out a number of features and vectors from a complex totality.

1.8 Conclusion: Exploration through drawing.

The history of drawing demonstrates that it has an ability to transfer expertise between domains, leading to new insights that would not have been possible otherwise. This process has often been facilitated by a willingness to develop these insights by routes other than those in current and general use, sometimes using apparently incompatible technologies as part of one investigative technique in order to do so. Examples are given of where this has been the case, in relation to anatomy and neuroscience. This thesis will also test how different drawing technologies can be made to work together as a combined or assembled method of inscription. Some of these are already in use in the field, such as tracing from video-screen, while others are new to it, such as multi-dimensional digital drawing and the use of co-located paper and screen images (Chap. 5).

The notion that to understanding a subject is best accomplished by studying it through drawing, has been an acknowledged mainstay in art since the nineteenth century. Ruskin stated that the process of observation should be led by a respect for the subject matter, and a deep immersion and consistent contact with it (Ruskin, 1971). This approach will be advocated below, where the guided and detailed observation of video data of human interaction has been instrumental to developing new techniques for drawing shared spaces (Chapter. 5).

The practice of drawing uproots aesthetic complacency in art. This was witnessed by those who saw the editing process of the abstract painter Piet Mondrian. Artist Carl Holty, who knew Mondrian in New York, wrote of the way in which his canvases were redrawn and then reworked.

Coloured paper was stuck to the canvases, constantly re-questioning the composition:

> Watching the pictures change into others as he worked, I asked him whether he wasn't losing good pictures in numbers because of his exigence. He said, "I don't want pictures. I just want to find things out" (Holty, 1957, p.21).

The next chapter considers in detail the ways in which human interaction has been depicted in the cognitive and social science literature.

Figure 1.21: Claude Heath, 2013. A typical drawing set-up at Queen Mary, London. **Above**, a computer monitor arranged above a 45 degree partially reflective glass surface, underneath which is a drawing sketchbook. **Below**, the monitor displays the source pdf with sequenced video frames, and does so upside-down so that the reflection is right way up, and can be 'traced' or followed on the paper surface below. This is a 'co-located' inscription method, in that the source image and drawing hand appear in the same place. The combination of the physical method and the prepared materials, results in an 'inscription device'.

Chapter 2

Survey: Representing shared space

Drawings of interaction in the literature of research on human interaction fall into two broad types: the first type shows single figures performing gesture and its co-occurring speech to off-camera investigators in laboratory environments; the second type shows two or more people in dialogue, also speaking and gesturing. The main difference is that the latter type of drawing shows a human interaction that is not experimental, and also shows how people orient towards one another and frame their mutual engagement with speech and gesture. Broadly speaking, figures in laboratories and in the field are both interactions of one sort or another, but the latter are naturally occurring and are unconstrained by the processes of scientific experimentation.

One of the questions that this survey will address is why researchers have drawn single figures from experiments as if they were part of a naturally occurring interaction, and why they have also drawn figures that are part of a naturally occurring interaction if they were part of an experiment?

Within the drawings a number of theoretical concepts are embedded. These are examined alongside prominent examples of drawing practices taken from the literature. Theoretical themes that emerge are presented as a spectrum that begins with representations of interaction that are

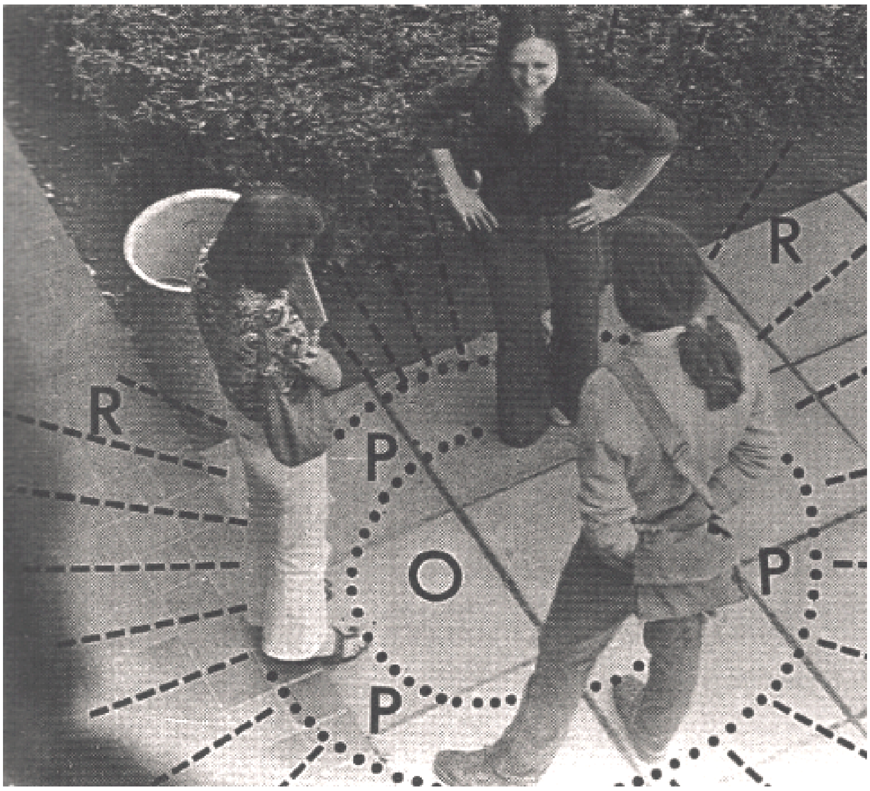


Figure 2.1: **Kendon, 1979.** The *f-formation*, and at the centre the *o-space*.

constructed around body-centric schemas, and at the other end of the spectrum there are those that represent shared interactional space.

The aim is to encompass the fullest range of the pictorial strategies that have been used by authors in order to show the direct communicational use of space in human interaction. Beyond this, the aim is to identify the types of phenomena that require new representational strategies, and this is reflected in the way that the survey has been structured.

2.1 Theme 1: Body-centric gesture space

Within the literature of human interaction, research specifically on the use of space in communication is very often underpinned by the concept of gesture space (Glossary A.0.2.21). However,

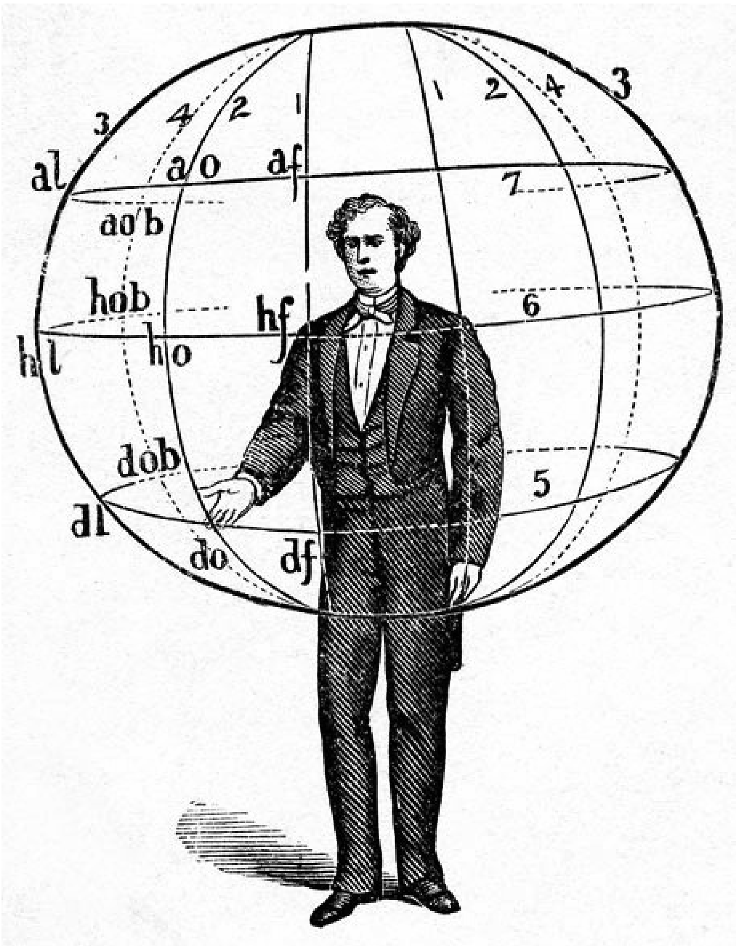


FIG. 5.

Figure 2.2: **Bacon, 1872.** Visualising body-centric gesture space as a sphere surrounding the orator, highlighting specific moments of a rhetorical performance.

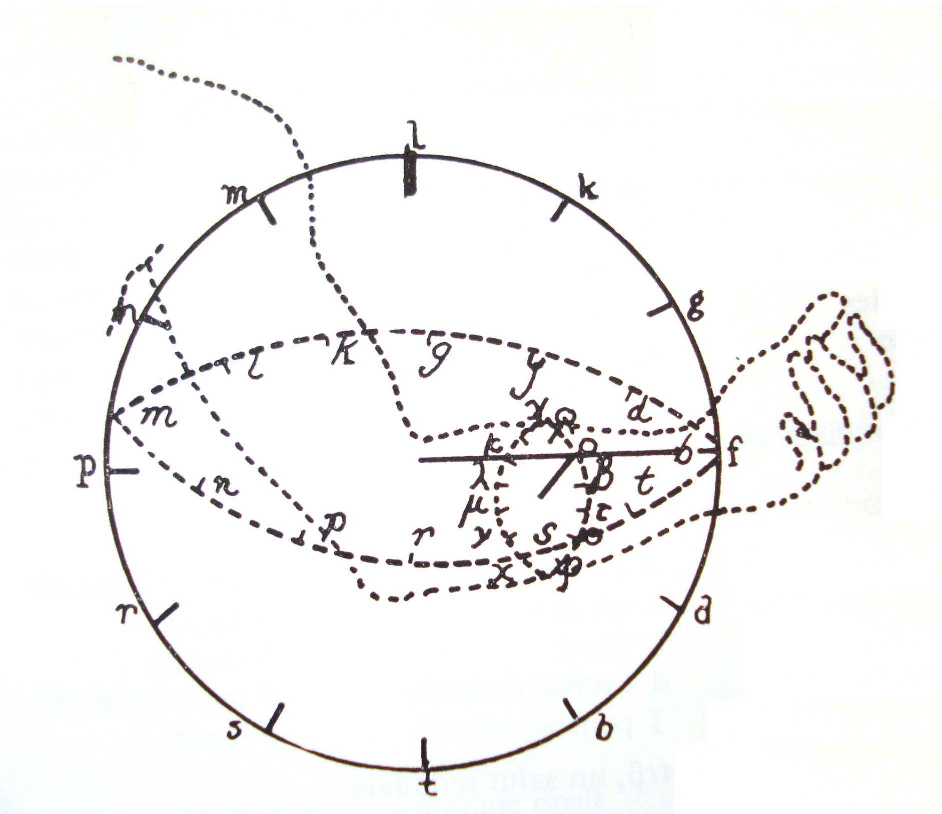


Figure 2.3: **Boussiac, 1973.** ‘La mesure des gestes’.

there is no single concise and agreed definition of what constitutes gesture space. The term is used in different senses by several writers, as will be shown.

Some have used the constraints and freedoms of the movement of the physical body to define the possibilities of communicative behaviours (Fig. 2.3).

Ray Birdwhistell's research group centred on 'kinesics', the study of patterned human movement and locomotion (Birdwhistell, 1952). The group maintained a film studio, resident cinemaphotographer and a full-time artist to visualise the results of the laboratory (Davis, 2001, and Schneider, 2011). William Condon's microanalysis of film was one of the descendants of this approach, applying exacting standards of observation to establish synchronies between mother and newborn child (Condon and Sander, 1974).

Bodily frameworks have been used to design what are intended to be universal formal notation systems (Bouissac, 1973, Martell, 2005, and Bressem, 2008). Others have remarked on the 'almost total lack of agreement on how movement should be described' (Badler and Smoliar, 1979).

2.1.1 Theory: 'A shallow disk'

More recently McNeill has developed a schema for gesture space, differentiating spaces within this by how they tend to be used (Fig. 2.5). Within these sits the 'space manikin', standing in for a single experimental participant. McNeill considers gesture space as a 'limited space', that 'can be visualised as a shallow disk in front of the speaker,' the lower half of which is truncated when the speaker is seated (McNeill, 1992, p.86). Deictic gestures are clustered (in terms of frequency of use) in the peripheral areas of the gesture space (pointing gestures are likely to be extending outwards towards their objects). By contrast, an 'iconic' or representational gesture is likely to be located somewhere within the 'center-center' region of the gesture space of the speaker, where discursive imagery is presented to frontally located addressees. McNeill therefore defines gesture space through the usages that differentiate this shallow space.

Coding practices following this schema refer to the zone of gesture space being used. This should be flexible enough to describe a gesture as a layered compound of iconic, deictic and metaphoric elements. McNeill observes that gestures commonly utilise space in so many ways that this is an argument for a typology of gestures with observably different functions (McNeill, 2005, p.88). It is possible that a single gesture could follow a path through more than one of his specified zones, but this is not discussed.

The mapping of gestural space is essentially two-dimensional, based upon a centred view of the figure, taken from a frontally shot video frame. The three-dimensional spaces of the schema are conceived in a rather flattened way, being contained in an approximately flat disk that is seen only from the front by a camera. Interaction-orientated authors prefer to say that an addressee builds a successively enriched and updated mental representation from the stimulus phenomena. This 'must be conceived in a multi-dimensional way reflecting the nature of physical movement itself in space' (Marchand, 2010).

Kendon's body-referenced units of analysis are termed 'transactional segments' (Kendon, 1990). These are a means of subdividing personal space (approximately 30 degrees in width). He says, 'spacing and orientation is measured in terms of their lower bodies', which in the case of a standing person is determined by the placement of his feet (Kendon, 1990, p.211). This segment is defined as that 'extending in front of a person', and 'the space into which he looks and speaks, into which he reaches to handle objects' (Kendon, 1990, p.210-11). It is established by how far a subject is able to look to either side without turning their lower body, while standing. These criteria are adapted slightly for seated interactions. The combination of several people's segments will produce an overlap that is itself irregularly framed on all sides by the segments of those people, and Kendon's identifies sustained patterns in the overlaps of individual transactional segments as 'f-formations', and that are managed and maintained by the group during interaction. The locus of a system, the *o-space*, is the place to which all members have this exclusive and direct access.

Research into sign-language for the deaf has identified emphatic use of forwards-moving

Figure 2.4: **Efron, 1941.** The use of different parts of gesture space around the speaker is shown in this standing figure with arrows and numerals to indicate sequencing.

gesture in ‘signing space’ to communicate the passage and direction of time (Crystal, 1987, Fig. 2.36). Efron did not explicitly discuss gesture space (Efron, 1941, Figs. 2.4, and 2.16).

Schemas are devised so that data treated with them can be transcribed and read in a specific way. This has implications for what can be discovered within the data. Describing the shape of gesture space, and attempting to picture the results of this, will inform the analyst’s understanding of the role of shared space in interaction.

In the view of some researchers, the meaning of communication is dependent on the individual (and their body) emitting a signal. An alternative view is that meaning emerges from the interacting group as a whole. Condon remarks on this dichotomy, saying that an experimentalist who is looking at the qualitative use of space should not ‘slavishly follow a physicalistic Newtonian model in the study of behaviour’ (Condon, 1980). The central frame of reference used to define an ‘interactive topology’ is the interaction itself rather than the individuals (Battersby, 2011).

2.1.1.1 ***Practice: body-centric schema drawing***

McNeill presents his results as two-dimensional plots of the occurrence of gesture types, superimposed upon the drawn gesture space schema, as a means of sorting and framing the data (Fig. 2.5). The drawing shows the regions where distinct types of gesture have been found. A series of intersecting boxes appear in front of the ‘gesture-space manikin’, and these boxes are populated with clusters of gesture types. This is frontally pictured (not seen from either side of the manikin). We can imagine that gestures made close to the body would not register in a gesture space schema that is a disk *in front of* the speaker, he says. In the diagram the *center-center* zone is placed in front of the lower edge of the ribcage, whereas elsewhere he writes of the slightly higher *manubrium* as the origin of the speaker’s gesture space. Close or ‘peri-personal’ space is discussed elsewhere (Sect. 2.1.5).

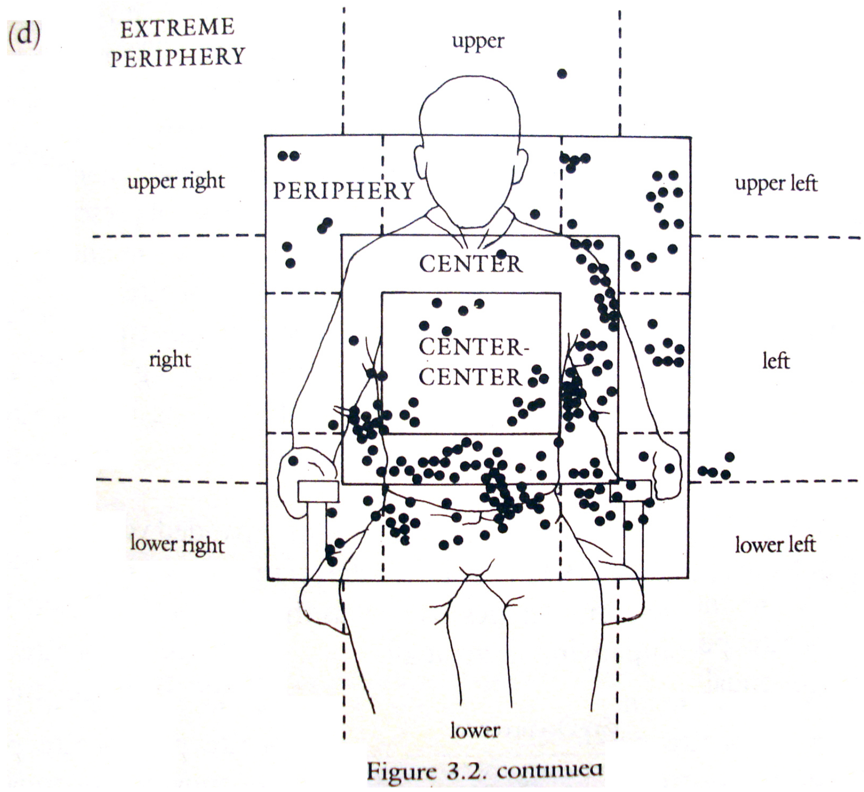


Figure 2.5: **McNeill, 1992.** Gesture space is schematised as a series of adjacent rectilinear zones that are positioned relative to the centre of the speaker's body.

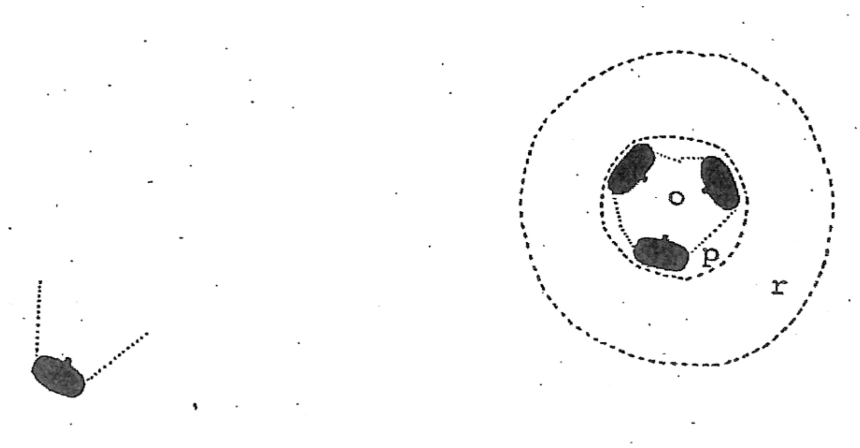


Figure 2.6: **Ciolek and Kendon, 1980.** Drawings of individual transactional segments with short dotted lines projecting forwards, oriented so that the common overlapping zone forms the focal *o-space*, which is in later work is surrounded by the *p-space*.

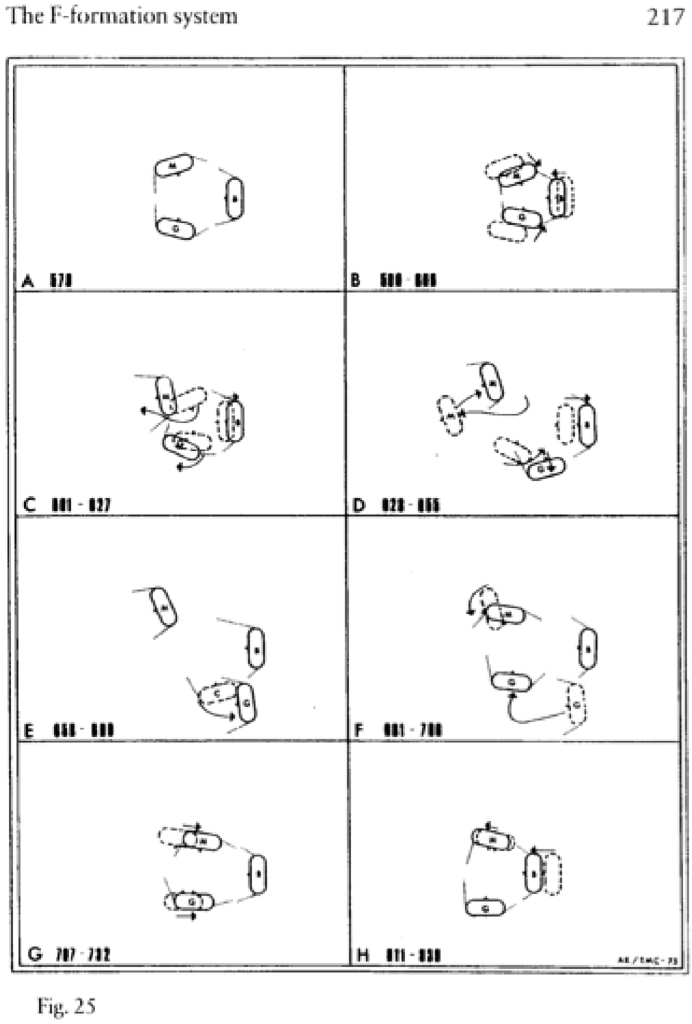


Figure 2.7: **Kendon, 1990.** Each new re-orientation of the *f-formation* is represented in a new panel with corresponding frame-numbers.

In contrast, Kendon draws interactions as seen from directly above. His subjects nestle within a wedge-shape that fans out in front of them (Kendon, 1990). For a picture of a similar construct please see Appendix. E, Fig. E.4. Kendon's overhead view is designed to show the distributions of overlapping individual segments at a distance from their bodies. The graphically constructed intersections of these segments are the first step towards delineating the body-centric shared space of more than one individual, and Kendon calls these *o-spaces* (Fig. 2.6). Dotted lines encircle these spaces. McNeill's schema depicts how a solo figure uses the space immediately in front of them. Kendon's data, also derived from the moving image, is drawn into plan diagrammatic views of 30-degree forward facing segments. On a later occasion these are placed in a *time-series* or *small multiple* (Tufte and Graves-Morris, 1983, see Glossary A.0.2.14). These contain several separately labelled panels, which are used to present an analysis for each phase of an interaction (Ciolek and Kendon, 1980, Fig. 2.7).

Individuals are orientated so that their transactional segments face one another in a variety of ways. The direction that the segments are facing are given by short lines projecting at an angle from either side of the torso, a device that is used in earlier and later versions of the *f-formation* diagrams. Gestures are not represented, only larger bodily movements are indicated with solid arrows. Interactional shared spaces are not represented in the small multiples. Instead, each individual is lettered in sequence and shows the film frame numbers that are referenced. Earlier bodily positions are differentiated with dotted line.

Moving-image data is not intrinsically three-dimensional and so is not suited to precise determinations of space. The decision to use a rectangular format in McNeill's schema, may be related to the deployment of a simple planar template to overcome the technical difficulties with applying a sphere-based schema. Such a template can be provided as a transparent film to be placed over computer monitor screens, to act as both a guide for analysts and a surface to mark. Such a process also has the advantage of the user being able to remove the transparency temporarily, gaining a better view of the screen, confirming observations, switching between software applications, and transferring observations and notes between these. Protocols for spatial coding must be designed to be read by those with low as well as high spatial abilities. Instructional diagrams for kit assembly have been shown to be more effective if they are designed with this in mind (Tversky, 2007).

Just as the lines denoting the facing direction of Kendon's transactional segments are truncated, McNeill's schema simply shades off into the peripheral extremities. The edge of gesture space is not shown or defined. It is noticeable that the dashed lines that represent the separation between left side, centre, and right side, run in line with the shoulders of the manikin, as do the schemas of Kendon and Klima and Bellugi.

A simplified plan-view that employs individual segments of 30 degrees, uses the shoulders as the origin points for the transactional segments. To draw these segments in this schematic way is considerably more convenient than to draw segments that are nuanced by the shape and disposition of the body, head, and feet, and are constantly changing in orientation and in relation to one another.

If Kendon draws data from above, how would McNeill's data be drawn from this same point of view? What patterns would be visible? The forward and backward movement of signers' gesture is shown in the second panel of Klima and Bulligi's illustration (Fig. 2.8). In McNeill's schema this spatial and temporal information would not be apparent, since he specifically represents relations of placement. Ideally two views of the data could be constructed, giving the viewer a chance to conceptualise these two projections as one. The main advantage of McNeill's approach is that gesture vectors and other details do not obscure trends, such as where iconic gestures tend to be placed in the 'shallow disk' of gesture space. The relational aspect of diagramming is important to express time relationships that stretch from the past [behind] to the future [forward] (Sect. 2.2.3).

McNeill's 'space manikin' (the term implies it is primarily intended to be used as a guide for other work) has been adopted and supplemented by a number of researchers who also address its shortcomings (Ladewig, 2011). Bressem prepared a notational system which aims to improve the characterisation of the parameter 'position.' She says that when exploring 'the common use of space by interactants, McNeill's gesture space is insufficient, because it conceptualises the gesture space as a two-dimensional space in front of the speaker' (Bressem, 2008, and Bressem and Ladewig, 2011). Furthermore, Rodrigues' study of Angolan students in interaction concludes that schemas such as McNeill's should be revised so as to take a more flexible view of the interplay between peri-personal space, gesture space and interactional space (Rodrigues, 2010,

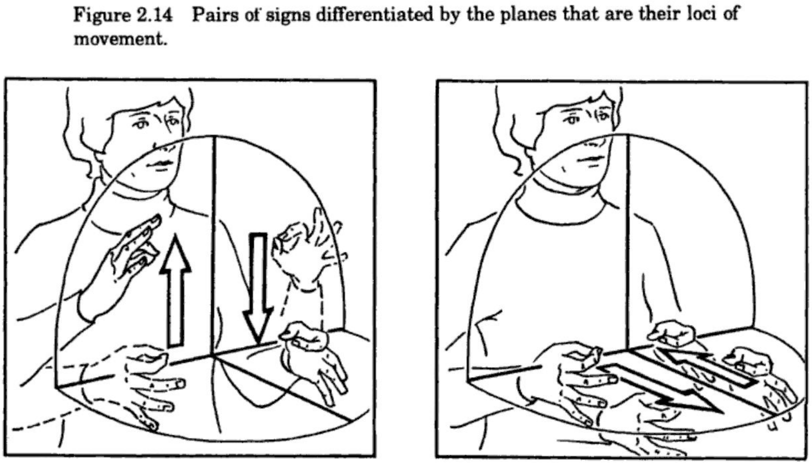


Figure 2.8: **Klima and Bellugi, 1979.**The loci of sign-language gestures shown in relation to vertical and horizontal planes of gesture space.

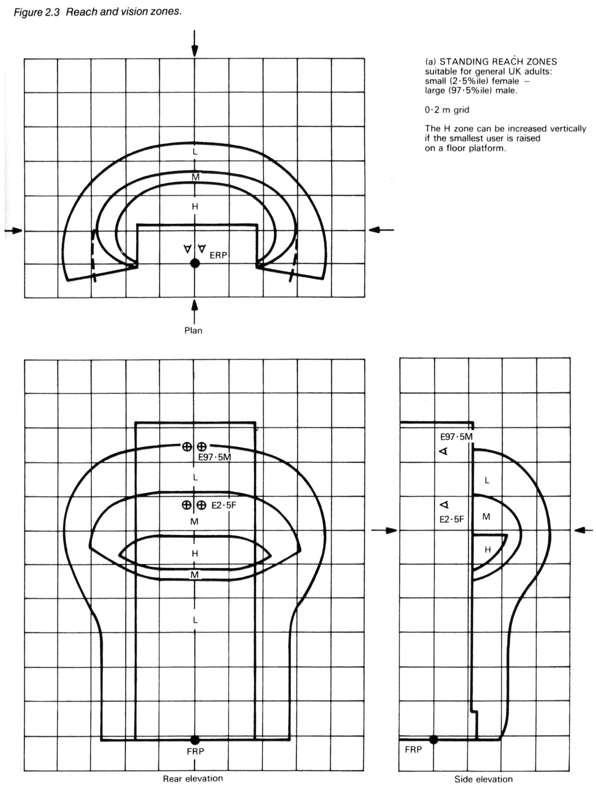


Figure 2.9: **Cortlett and Clark, 1995.** Ergonomic workspaces, seen from threes sides.

Fig. 2.47). The tension between frontally acquired data and the need to describe space more fully is expressed in these dissatisfactions with current gesture space schemes.

Bressem's addition of *distance-from-body* values to McNeill's schema was as follows:

0 = speakers own body.

1 = close distance to the body.

2 = middle distance from the body.

3 = far distance from the body.

Figure 4: diagonal orientation in relation to body centre line (viewed from above)

Figure 2.10: **Bressem, 1998.** Gestures shown with coding type, without distance-from-body values.

Relational notations such as Bressem's are not well suited to representing the dynamics of gesture and interaction, because of their segmented nature (Sect. 2.1.4). Notations can have negative values attached to them, and are intended for use with video annotation tools. In these, separate channels can be added to describe the spatial distribution of gestures, identifying them and co-speech with specific portions of gesture space. A further level of representation would be required in order to textually represent the shared space of an interaction.

Writers have applied McNeill's schema to motion-capture studies, inserting it into their data as a two-dimensional plane (Fig. 2.13). One corpus on pointing gestures, presents multi-dimensional data against the backdrop of the 'space manikin,' as the schema is called (Pfeiffer, 2010, Fig. 2.11). Data from an experimental subject is seen in front of a resolutely flat McNeill schema, which was designed to be applied as a coding to two-dimensional video (Fig. 2.12). Arrays of pointing gestures have been mapped onto the table in front of the subjects. These renderings are essentially graphs that contain high-dimensional relational data as images (Tufte and Graves-Morris, 1983b).

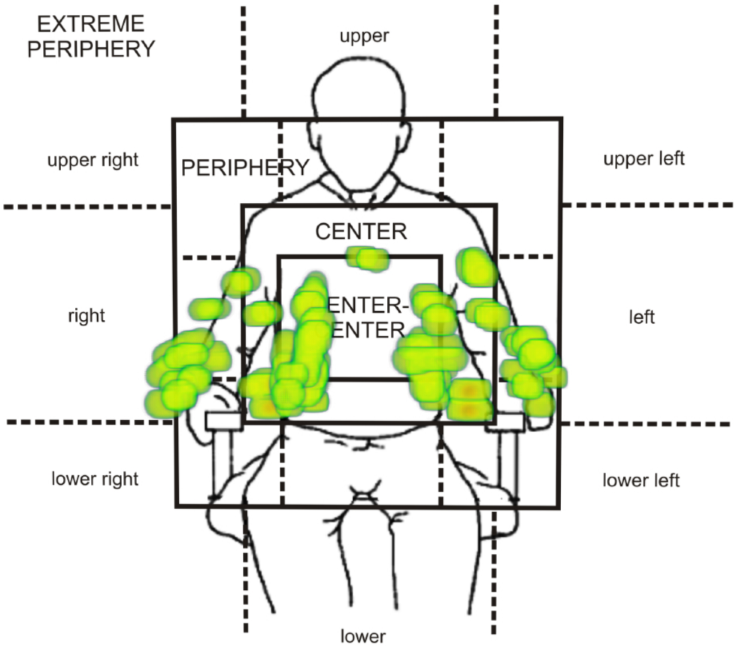
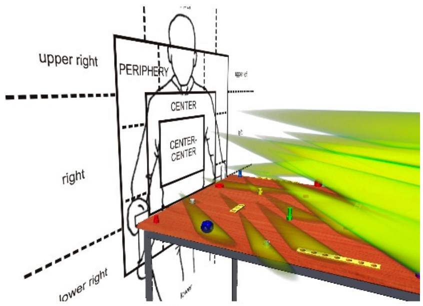
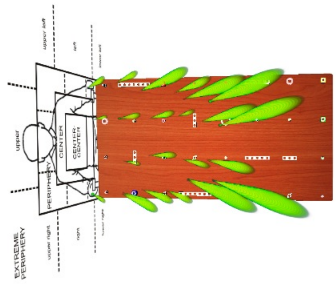


Figure 2.11: **Pfeiffer, 2011.** Motion-capture data from a study on pointing, seen here frontally mapped onto McNeill's gesture space schema.



(a) S+G Trials



(b) G Trials

Figure 2.12: **Pfeiffer, 2011.** Motion-capture data from the same study, seen here obliquely mapped and in plan-view, also incorporating McNeill's 'space manikin'.

Fig. 8. McNeill's grid defining different areas of gesture space

Figure 2.13: **Rodrigues, 2010.** Video data of the student interaction incorporating McNeill's schema as a grid.

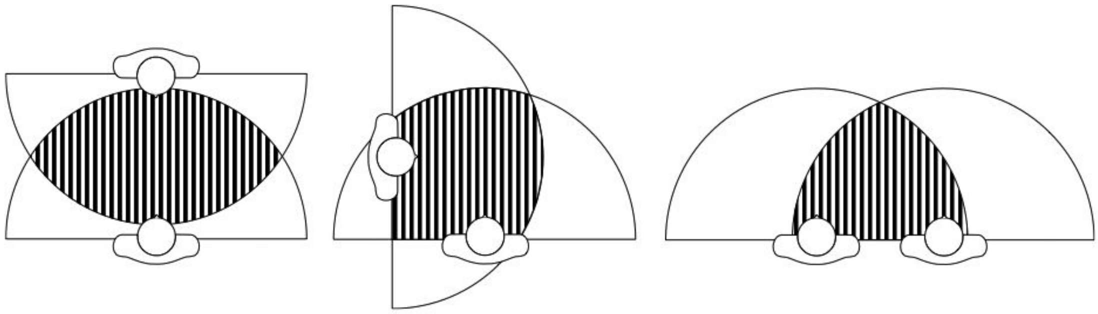


Figure 2.14: **Nguyen and Wachsmuth, 2011.** Three configurations of overlaps in schematic gesture spaces.

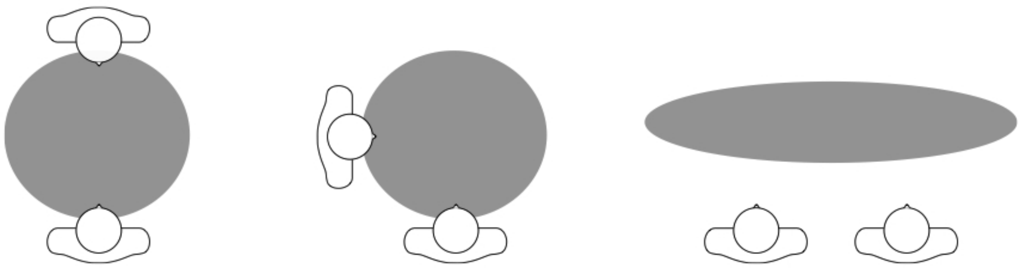


Figure 2.15: **Nguyen and Wachsmuth, 2011.** Alternative visualisation of the same configurations, showing hypothetical o-spaces derived from the schema.

Other drawings from the same laboratory represent schemas for peri-personal and forward-reach space, as well as configurations of interactional space (Nguyen and Wachsmuth, 2011, Figs. 2.14, 2.15, and 2.25). In both cases these have been produced from metric criteria based upon body dimensions, rather than from empirical observation, due to the focus on modelling robotic behaviours (Fig. 2.24. The side-by-side formation that produces an elongated oval, for example, which is not framed by other interactional spaces such as Kendon's *r-space* and *p-space*, discussed below (Sect. 2.1.2).

Linking analytic concepts such as gesture space to the physical capacities of the body, effectively ties the representations of these concepts to metric space. Likewise, it should not be forgotten that Pfeiffer's semi-transparent and cloud-like shapes representing deictic gestures are in fact tightly measured and rigorously defined volumes.

Multiple view-points upon data are scarce in the literature, reflecting the uncertainties that researchers have felt concerning the extrapolation of new views from their ethnographic and video-based experimental lab data. Extracting from their data can yield considered and rounded representations of the use of space in communication, as is the case with motion-capture data. It is also possible with moving-image data, especially if more than one camera is in use. Single camera data has also been used to gather precise spatial readings (Appendix. C).

2.1.2 Sub-theme: deictic framing of gesture space

We can separate out some of the different usages of 'deixis' (and related terms), in order to refine our understanding of them into two distinct categories of usage. The primary sense of deixis is to point and to locate meanings concerning referents. There is also a secondary sense in which, as McNeill and Haviland state, gestures point to their own 'place' in space (Haviland, 2000). This is the context of the assertion that gesture space is 'deictically framed.' These two related but distinct usages can be referred to as *Deixis1* and *Deixis2*:

- ***Deixis1*** concerns the readily understood usage from linguistics, where understanding the meaning of certain words and phrases in an utterance requires contextual information. Words are deictic if their semantic meaning is fixed but their denotational meaning varies depending on time and/or place. Such additional contextual information can be carried non-verbally via gesture and gaze, for example.

- ***Deixis2*** relates to the semiotic dimensions of deixis, iconicity, and metaphoricity, that are layered into a wide range of gestures, including pointing and other types (McNeill et al., 2007). These layers cannot be understood independently of one another. Any gesture

Figure 2.16: **Efron, 1941.** Gesture points to its own 'place' in space, deictically framing an individual's gesture space. This drawing is unusual because of the new vantage point taken for the gesture numbered 4, in order to show the movement type in a way that can be appreciated clearly and separately from others.

therefore is intertwined with where it is placed in space: for example, a metaphoric gesture occurring at particular location in space will also have a layer of semantic meaning that points to that place. All gestures therefore manifest deixis, or we say, are 'deictically framed', whether this involves pointing or not.

A description of *Deixis1* is given in Haviland's discussion of narrated interactional spaces, where a gesture space is one that projects out from and around the act of deixis, or pointing (Sect. 2.2).

2.1.2.1 ***Practice: drawing the deictic framing of gesture space***

Deixis2 has been pictured, albeit indirectly, by researchers (Efron, 1941, Fig. 2.16). A similar effect can be seen in Bacon's depiction of oratorial gesture space (Fig. 2.2) and in McNeill's gesture space schema (Fig. 2.5).

Kendon's conception of transactional and segmented space is essentially a spatio-orientational frame of reference that is body-centric (Fig. 2.7). This theoretical apparatus has a framing effect on the data by establishing the boundaries of spatial configurations and the events that happen within these spaces. For Kendon, the overlaps between these body-centred segments produce 'joint transactional space', and this jointly maintained *o-space* (Kendon, 1976, Fig. 2.1). The presence of such a space is indicative of the presence of an interactional configuration or system, incorporating reference to space conditioned by being shared rather than by being related to personal spaces of the body (Fig. 2.6). The segment and the *o-space* can be conceived as a slice of the environment that an individual faces, and this helps the analyst to narrow this large field of experience into a smaller and shared field.

The interest in how to establish the imagistic and linguistic boundaries of phenomena in interaction can also be found in Schutz's notion of the 'horizon' of a phenomenon (Schutz, 1967). Growth Point theory is described by McNeill (in correspondence) as "growth' in the sense that it is the seed out of which speech and gesture grows' (Montredon et al., 2008).

2.1.3 Theory: layered space

McNeill and Pedelty study single-speaker cartoon narration (post-viewing). The narrations of brain-damaged patients reveal how narrative structure (‘a complex of meanings’) relies upon the brain’s capacity for spatial organisation and narratives by patients whose abilities to abstract are impaired are consequently disrupted (McNeill and Pedelty, 1995, and Pedelty, 1987). From their observations of patients they deduce the operation of three ‘spatial regimes’, the demands of which must be balanced in ordinary behaviour. These have increasing levels of abstraction:

1. *Concrete Space* is the least abstract regime, a pathway or vector in physical space, and must include reference to the body.

2. *Referential Space*, where gesture space is separated into areas that represent different characters within the narration.

3. *Structural Space*, is used to set up new themes, or to maintain cohesion between newer themes that are set beside older ones in the less abstract referential space regime.

Deixis2 discovers patterns of disruption in normal gesture space, contrasting this with normal (consistent) states of affairs. Psychological dissociation is a distancing from Concrete Space that is out of the ordinary. For example, an inability to match physical and abstract content, or an inconsistent treatment of boundaries within the narrative, are indications of dissociation.

Any single gesture has a double function: it can represent an event in the story being narrated, while it can also stand for the edge or boundary of one part of the story (*Deixis2*). A story-event can be iconically represented in gesture and speech, while also establishing that this is a different scene from the previous one. One utterance and gesture thus mark two ‘regimes’ at once, the Concrete and the Structural for example (McNeill and Pedelty, 1995, p.66).

2.1.3.1 ***Practice: drawing layered space***

The literature does not contain drawings that expressly address semantic layering and the three spatial regimes mentioned above. Haviland and Wilkins publish drawings including cardinal directions and maps, thereby visualising another layer of meaning (Fig. 2.2.1.1, and 2.30). Emmorey draws a distorted topographic space in front of a seated female ‘space manikin’ (Fig. 2.45). Many of the drawings reproduced in this review of the literature exhibit a degree of layering in this way.

2.1.4 Sub-theme: gesture dynamics

‘Gestural embroidery’ is a term coined by Efron to describe the convoluted gestural pathways observed in New Yorkers. McNeill improves upon, refines, and redeploys the schema of gesture classification first instituted by Efron. The sub-theme (gestural embroidery) relates to the mechanisms that unify a whole discourse. McNeill’s colleague and co-author Susan Duncan notes that the ‘genius’ of gesture is that it does not need to segregate meaning into temporally discrete units, and effectively spreads its meanings beyond the present moment (McNeill et al., 2007).

Efron wrote of:

> ‘quasi-syllogistic’ zig-zagging configurations of thought. These movements chart the “heights” and “lows”, “detours” and “crossroads”. Each turn or twist in the movement corresponds to ‘a change in the “direction” or in the altitude of the “curve” of thought.’

A hand can link one proposition to another, or to ‘trace the itinerary of a logical journey’, and many of the published drawings (made by Van Veen) illustrate the vectors associated with these patterns (Efron, 1941, p.99, Fig. 2.18). Efron finds that the typical Italian speaker is inclined to ‘illustrate gesturally the objects of his thinking’, and this is contrasted to more abstract ‘notation of thought’ made by Jewish subjects (p.98-9).

Maintaining a sense of the unity of a discourse is an issue when language and gesture are subdivided into increasingly smaller units for analysis. The same is true of visual forms of analysis. Smaller units of analysis should ideally be presented in such a way that the whole discourse is not lost to view.

McNeill says gesture and language form a unified system, and that gestures are an integral part of language as much as words, phrases, and sentences (McNeill, 1992). The flexibility and idiosyncratic nature of gesture allows a tight intertwining of speech and action, revealing the speaker's implicit imagery and thought. McNeill and Pedelty describe the ability of a speaker to use a series of 'spatially coded coreferential chains', or gestures accompanied by words, that 'ribbon their way through long passages' of narrated text (McNeill and Pedelty, 1995). It is this metaphorical 'ribboning' that provides unification at discourse level.

2.1.4.1 ***Practice: gesture dynamics***

David Efron employed american artist Stuyvesant Van Veen. He was briefed to record characteristic gestures made in natural social settings (Fig. 2.17). Some of these sketches later served as a basis for reworked drawings for publication, merging detail of dress and facial expression that were contained in initial sketches. It is not recorded whether Van Veen co-designed with Efron the method of constructing vector-based graphs of gesture from film-footage ('kinesographs,' of which there were nearly two thousand).

In a personal communication with Jay Ruby in 1976, Van Veen stated that he became quite involved in the work of drawing the interactions, to the extent that he began to talk to the participants (it is not stated whether this was during, before, or after the drawings were made). He thus became a source of data for Efron, and this is evidenced in the publication, where Efron directly quotes some of Van Veen's observations on the interactions (Ruby, 1980, and Ruby, 2000, p.63).

A typical 'kinesograph' illustrates the dynamics of gesture (Fig. 2.18). A pair of ribboned vectors, one for each of the speaker's arms, is annotated with frame numbers to allow a cross-comparison to be made as to their relative progressions. An arrow-head is placed at the beginning of the vector, with the frame number inscribed within. Meanwhile, at the end of the ribbon are Maltese-cross shapes, also numbered with the last frame in the sequence. In this way we know that this particular gesture was embroidered over thirty frames of film, and which parts of each ribbon are approximately corresponding. However, no co-speech is given, reminding us that the target concept was the degree and type of physical movement.

Since Efron gesture dynamics have been drawn in the literature in a variety of ways, none of which depart significantly from this precedent. Signing research employs similar arrowing for example (Delaporte and Shaw, 2009, Fig. 1.1). Drawings of signing have also expressed fine-grain dynamics over several phases, drawing the differences between each successive frame (Fig. 2.19, and 2.20). Alan Gilbert, music director of the New York Philharmonic, was recorded by motion-capture demonstrating his conducting [1] (Fig. 2.21). The graphical representation of dynamics depends for its effectiveness on unifying several analytic strands into one image. In the current example, gestural and musical dynamics must be aesthetically combined, in such a way that a 'line of beauty' is constructed, illustrating the artistic purpose of the movement while also carrying forward the crafting of technologically supported visualisation with gracious curves (Howard, 1985). Such representations are designed to be seen as stills and also as animations for public consumption. They are not usually paired with speech transcripts, and so fail to convey the topical patterning of space. Instead the images rely on animated algorithmic fading of the trailing line of movement. Gilbert is quoted, discussing his role as a conductor to communicate with his orchestra using gestural and musical lines of movement:

> It's not just a monolithic, homogenised texture. Its a texture that hopefully works well together, but has local features, based on how each individual line moves.

[1] http://www.nytimes.com/interactive/2012/04/06/arts/music/the-connection-between-gesture-and-music.html

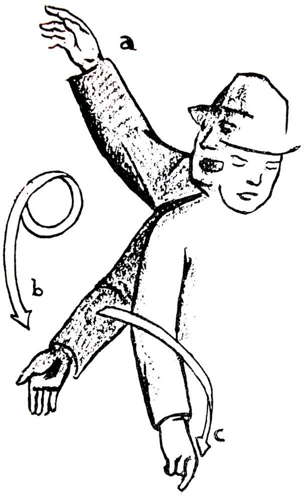


Fig. 39

Figure 2.17: **Efron, 1941.** Van Veen's sketch of a gesturing New Yorker.

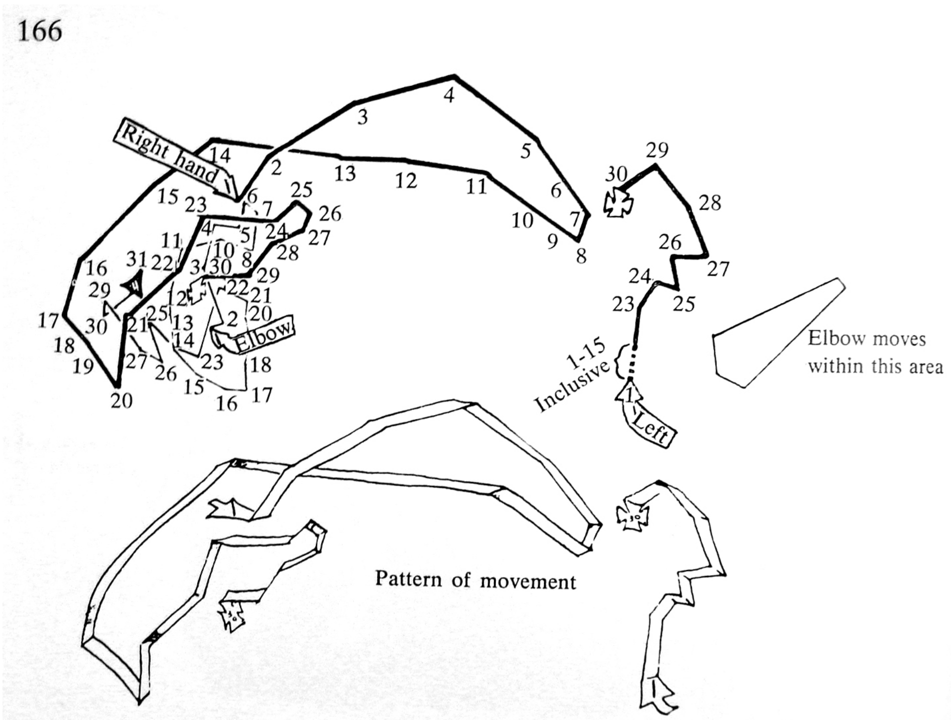


Figure 2.18: **Efron, 1941.** 'Kinograph' showing double-handed 'gestural embroidery' over 30 frames.

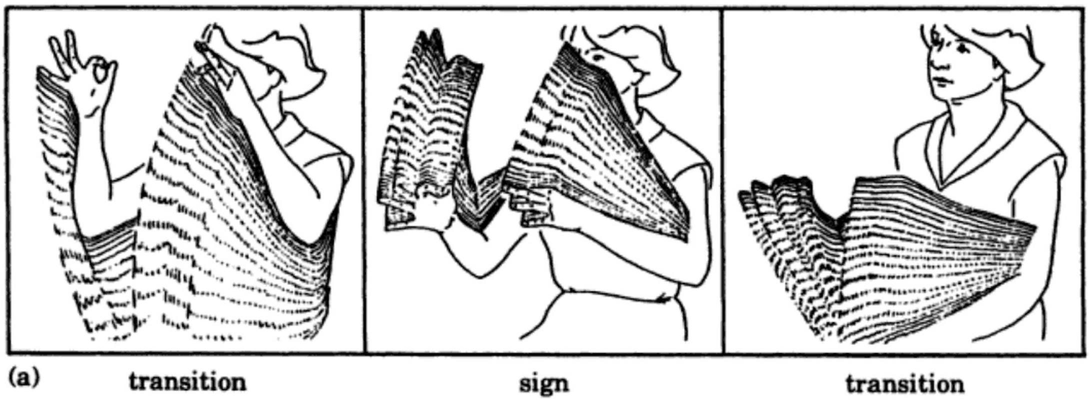


Figure 2.19: **Klima and Bellugi, 1979.** The dynamics of sign-language over three phases, drawing the differences between each frame.

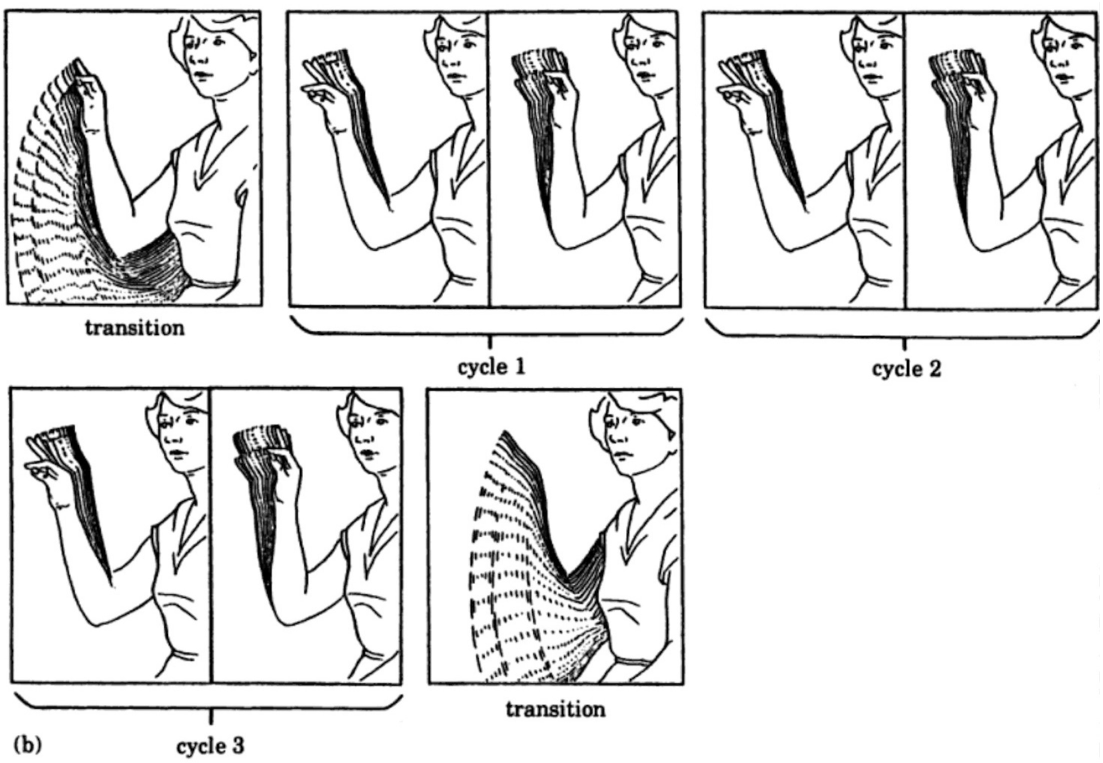


Figure 2.20: **Klima and Bellugi, 1979.** The dynamics of sign-language over five phases.

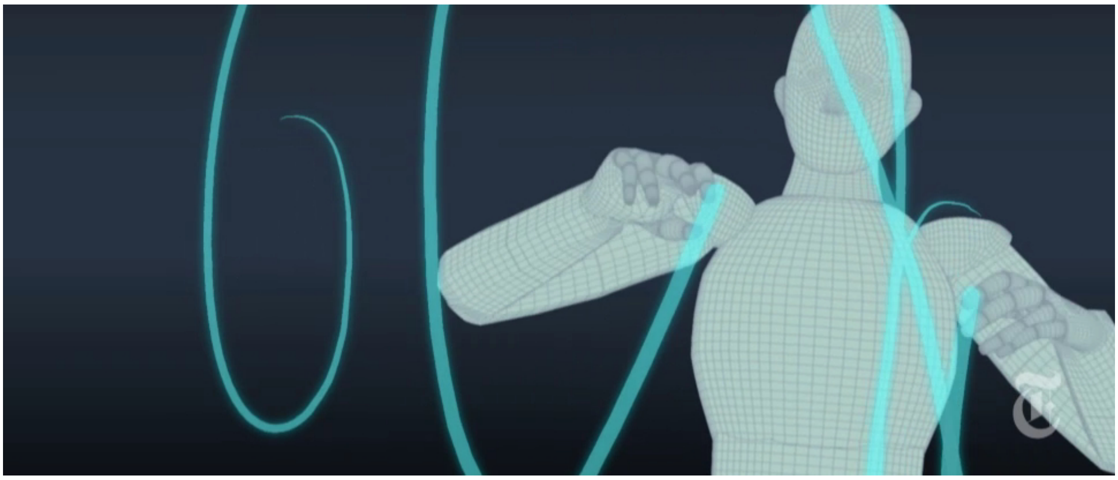


Figure 2.21: **Alan Gilbert, 2012.** The dynamics of conducting an orchestra recorded with motion-capture technology. Still from animation produced by the New York University Movement Lab.

*2.1.4.2 **Theory: 'catchment'***

Research has described embroidered gesture space in terms that relate to the speaker alone. McNeill's concept of catchment is 'a kind of thread of visuospatial imagery that runs through a discourse to reveal the larger discourse units that encompass the otherwise separate parts' (McNeill, 1992, p.117). This has been empirically observed in experiments where a subject narrates their recall of a cartoon that has just been watched. Catchment was therefore developed out of monologues to camera. This recounting shows the patterns that are 'a gesture-based window into discourse cohesion.' Several 'gesture features' can run through a discourse. These features link back into each other to form a set at a higher level of analysis. Moreover, catchment adds an 'imagistic' or 'non-linear' element to the dialogue. These have also been termed 'cohesives' (Glossary A.0.2.20, and A.0.2.16).

Catchment has also been studied in lecturing scenarios. With an audience out of camera view (Parrill and Sweetser, 2004) authors use the Blended Space model to facilitate their analysis (Liddell, 2000), separating out real space and iconic/metaphoric mappings. In this scenario, mental space is rigorously described but the actual space used in gesture is not. The authors do not attempt to insert or otherwise relate the diagrams of blended conceptual spaces into the drawn representations, and so the two types of graphics do not significantly intersect, although their coexistence raises the possibility that they may be made to coincide.

Parrill and Sweetser refer to limited data set showing only a solo speaker. Gestures are not referenced to interaction as such. Their discussion of this case is one of a very few examples of the concept of catchment represented in some detail.

2.1.4.3 ***Practice: 'catchment'***

McNeill cites political speech-making as an example *par excellence* of this type of eclectic 'meta-level' cohesive patterning, giving the example of Boris Yeltsin (McNeill, 2008, p.16, Fig. 2.22). Key images are read efficiently when arranged horizontally, and short segments of text are read effectively when arranged vertically, allowing the eye to rapidly scan up and down. Here, a vertical arrangement is used for both images and text.

A series of drawings has been collated from a single paper discussing catchment, but excluding the transcript and descriptions that accompany them in the original (Fig. 2.23). The drawings are of a figure in motion over five stages, without arrowing or other devices. They are designed to represent data interpreted as a 'spatially coded coreferential' chain of gestures that provide cohesion to part or all of a discourse.

The anonymous outlines of the figure been derived from the source video, traced either digitally or by hand with pen. These have been coloured with flat grey tones in *Photoshop* or equivalent software. Fey Parrill is also responsible for other illustrations from the McNeill laboratory, that also place similar illustrations among transcript excepts. These drawings mimic the photographic outputs (as seen in the example of Boris Yeltsin). By anonymising the subject and reducing the amount of background and other visual information, the drawings are aimed at pointing the reader towards the spatially coded patterns of behaviour. These are intended to be inferable from the drawings, but depend on text to do this.

The drawings also depend on catchment being a phenomenon where a degree of similarity is displayed in gestures. Yeltsin's hands set up a refrain with common features, 'one hand slicing down at the same locus of space, and different hand shapes.' The final gesture ('not a catchment') is markedly in different space and with a different hand shape, making his rhetorical point all the more effective. How would patterned phenomena that are not so similar be represented using these conventions? How would drawings in the form of 'small multiples' cope with these demands?

flat B-hand : *a paltry 30%*

through 2 fingers : *only five months and two days*

to 1-1/2 fingers : *President and I signed an agreement*

to 1 finger : *reduces the quantity*

to closed fist A-hand : *by the magnificent 300%*

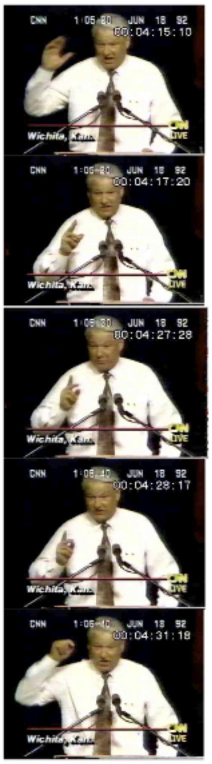


Fig. 1. Boris Yeltsin catchment. Video source: CNN. Collected by Brenda L. Connors.

All the gestures have common features, one hand slicing down at the same locus in space, and different hand shapes. This set of gestures differs totally from the next gesture:

Not a catchment 00:04:36:07 - :36:20 (half second)
TEXT: and eliminates the threat to the world

2 SHs move apart in lower center (1 stroke):

Figure 2.22: **McNeill, 2008.** Boris Yelstin. From: 'Gestures of Power and the Power of Gestures.'

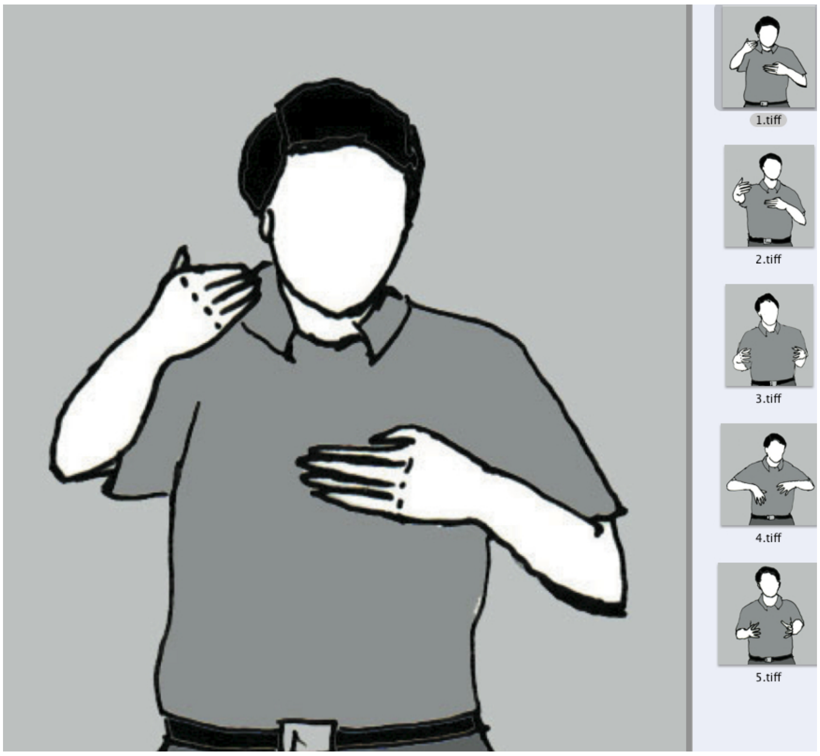


Figure 2.23: **Parrill and Sweetser, 2004.**Catchment in a lecturing scenario.

2.1.5 Sub-theme: peri-personal space

Peri-personal space is defined as the space in immediate proximity to a person's body, and has been studied experimentally in relation to tool-use. The 'plasticity' of peri-personal space is a relatively recent topic in neuroscience. This work has implications for ethnographic studies of the use of tools in shared space, including architects working upon drawings with their pens, as seen in the Case Study (Chap. 3).

Different regions in shared space lend support to different interactional cues, perhaps for different members of the interaction (Battersby, 2011). The support for these coordinating cues within the group will be concerned with spatial management. Holding a pen for example, pointing and drawing with it, changes the nature of the space for the tool-user, and this change is felt and reciprocated within the peri-personal spaces of others. While working with these drawing tools at arms reach, jointly managed space is subtly changed. A pen held at full stretch re-maps a drawing sub-space as 'near', whereas without the pen it had been mapped as 'far' (Berti and Frassinetti, 2000). This quality of 'nearness', when felt by a group, creates a link between disparate physical spaces, and could be used in a body-centric analysis of collaboration, as a criterion of shared spaces.

Holmes and Spence say that multiple perceptual frames of reference are in use at different times for different tasks (Holmes and Spence, 2004). The tool-user's visual frame of reference begins with the head and face during some tasks, and is centred on the hands during other tasks. A genuine extension or expansion of peri-personal space, they say, is during a target-retrieval task. Their experiments positioned artificial body parts in illusory orientations with respect to actual body parts. This shows that apparent but ungrounded modulations in tactile perceptions alter the brain's representation of 'visuotactile peri-personal space.' This account of 'extended' peri-personal space can be compared and contrasted with Haviland's description of gesture space as a 'projected' narrational space (Sect. 2.2.1). Holmes and Spence find that different perceptual modalities must be processed in the 'rapid, plastic re-mapping' of space as these tasks unfold. There is a complex and delicately balanced relationship between peri-personal space, extra-personal visual space, and the full 'body schema' that is derived from all of these.

Pfieffer's results from motion-captured data create a dichotomy in gesture space between a proximal area, closest to the body, and a distal area that corresponds with the length of an arm (Pfeiffer, 2010). He does not represent these zones in his own diagrams and representations. McNeill's schema, according to these results, will be a shallow disk of nearly 90 cms depth, and of an unspecified height (Sect. 2.1.1).

2.1.5.1 ***Practice: drawing peri-personal space***

Schematic drawings of peri-personal space have been found in the literature, dotted circles and ellipses highlighting zones of close personal space. Holmes and Spence visualised zones of the far-end, middle, and near-end of tools that were used at a distance during tasks. Their hypothesis diagrams (Fig. 2.27) were re-drawn together with their experimental set-up diagram (Fig.

2.26). They have been superimposed for the purposes of this review, in order to create a richer picture of the implications of this research (Fig. 2.28). The composite image does not deviate from the drawing style of the researchers. It is a representation of the hypothetical areas of neurological change in neurologically tested peri-personal space (the hypothesised 'visuotactile' representations of peri-personal space in the brain).

They are overhead views and the subject is not shown in realistic proportions. The highlighted areas are intended to indicate a region of possibility, of potential neurological remappings of peri-personal space that they expect to find through experimentation. The broken line is intended to convey that the zones are not physically manifested and do not have hard-edged boundaries.

Regions of possibility or potentiality have been visualised schematically by Nguygen and Wachsmuth as overhead views (Fig. 2.25). These diagrams are technically exact and unambiguous. This is to be expected since they specify robotic 'work envelopes' and are therefore depicted as rigidly defined metric spaces. Concerned with human-robotic interaction, they have modelled peri-personal space as a 'tangential' potential field, while 'goal space' for gestural actions is a 'selective attraction field' for robotic agents (Nguyen and Wachsmuth, 2011). Fields are capable of mapping the objects of joint interest, resembling a diagram of opposing electromagnetic fields (Fig. 2.24). The breaking-down of peri-personal space into its various modalities (touch space, lean-forward space, visual attention space) is comparable to workspace ergonomics diagrams (Fig. 2.9).

Research on peri-personal space (both human and robotic) offers possibilities for visualising qualitative spaces in interaction more generally. The drawings do not generally represent these modalities, or the fact that there are several frames of reference in operation at any one time (spatial, perceptual, and neurological, for example). One exception to this is the drawing of robotic attentional fields, which depicts differently patterned types of space (Fig. 2.24). The sparse and schematic nature of the drawings should not detract from what they are intended to convey. The dotted zones represent new peninsulas of attentional space, and have great potential for extending this approach into representing fields of shared interactional space. The hypothetical or speculative aspects of the published drawings are yet to be fully explored and extended. In their current form they are comparable in style and purpose to the schematic overhead views of the range of possible configurations of shared space, made by Emmorey (Fig. 2.46).

Temporary projections of peri-personal space onto the tip of a tool have implications for drawings of human interaction. Peri-personal space extends or projects outwards, as if a new visuo-tactile peninsula or island of attentional space was being created. (Interestingly, as far as representations within the brain are concerned, Holmes and Spence say that these often relate to the ends of the tools).

Reciprocated movement in interaction implicitly demonstrates the convergence and congruence of shared cognitive maps (of peri-personal spaces). This is especially true of visuo-tactile phenomena, for example where a ‘virtual gestural maquette’ is produced (Sect. 2.2.11). In this case a drawing of the phenomenon should represent the rapid remapping of topical spaces in relation to each other (Healey and Peters, 2007, and Heath and Healey, 2011).

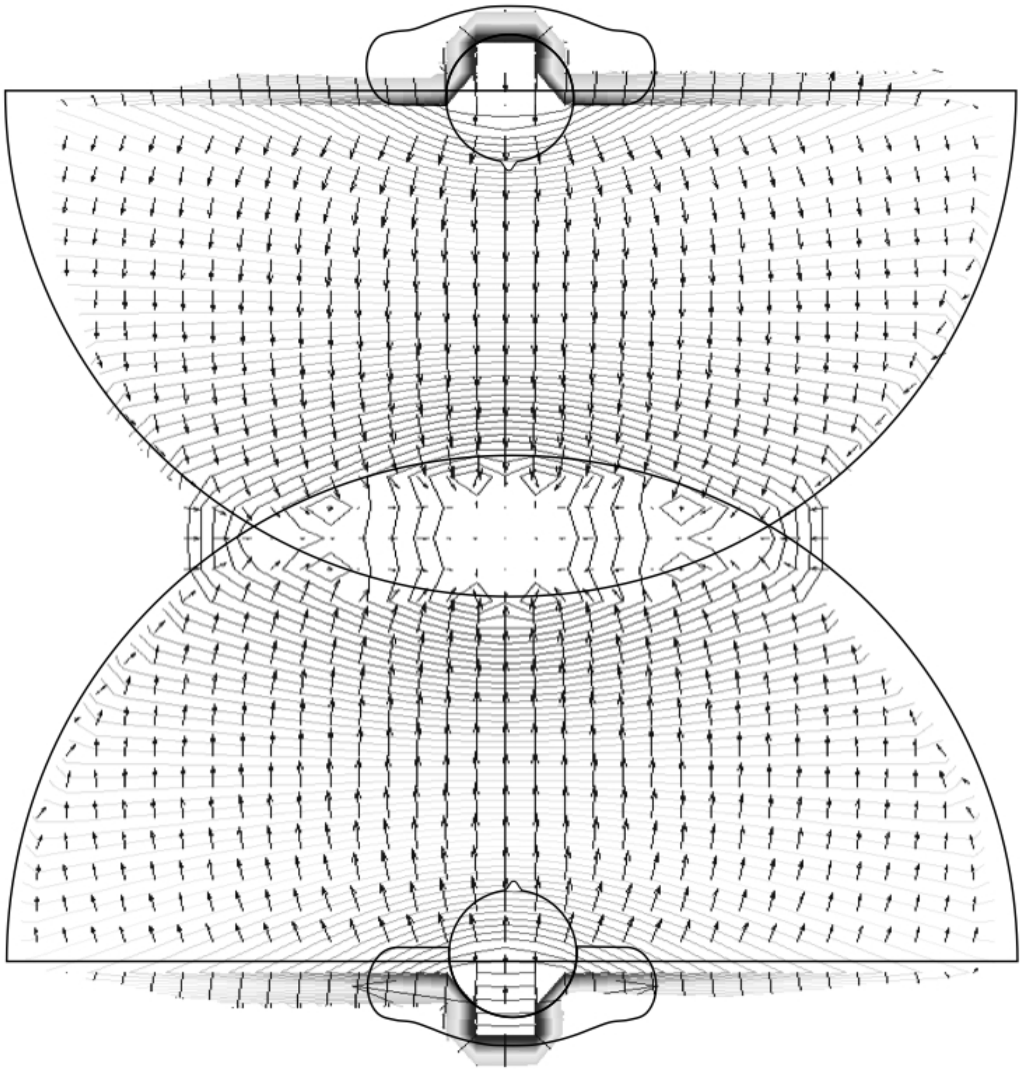


Figure 2.24: **Nguyen and Wachsmuth, 2011.** Robotic agents possess a 'goal space' for gestural actions, a 'selective attraction field.'

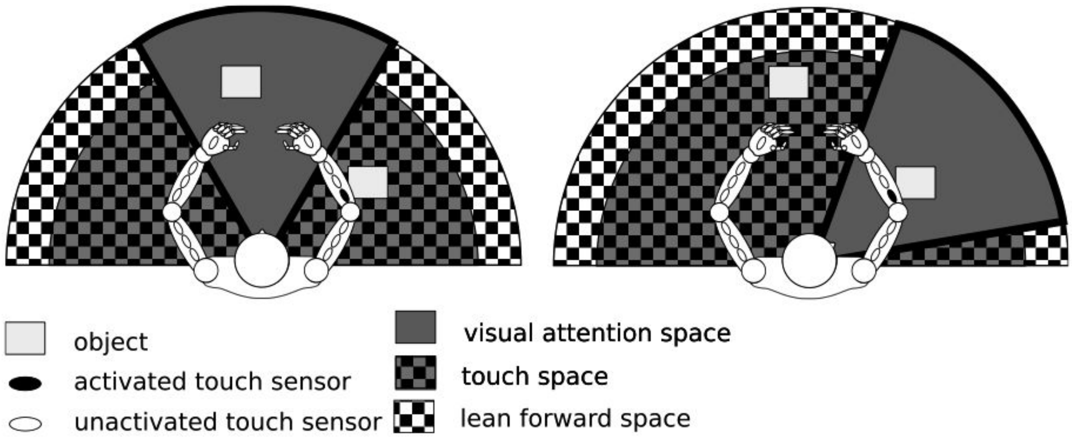


Figure 2.25: **Nguyen and Wachsmuth, 2011.** Robotic agents possess a ‘goal space’ for gestural actions. Plan views of reach space and forward reach space are patterned differently.

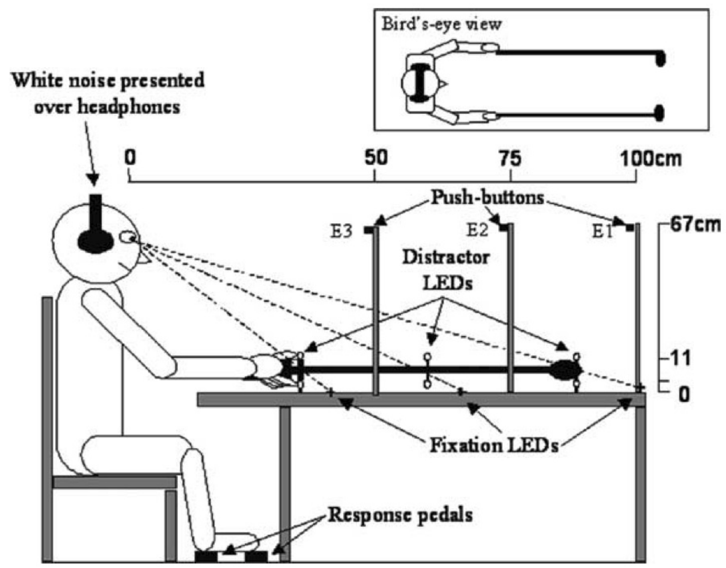


Fig. 2. Participants held a tool in both hands (see inset), and fixated one of three central fixation LEDs (depending on the visual distractor distance).

Figure 2.26: **Holmes and Spence, 2004.** Experimental set-up diagram.

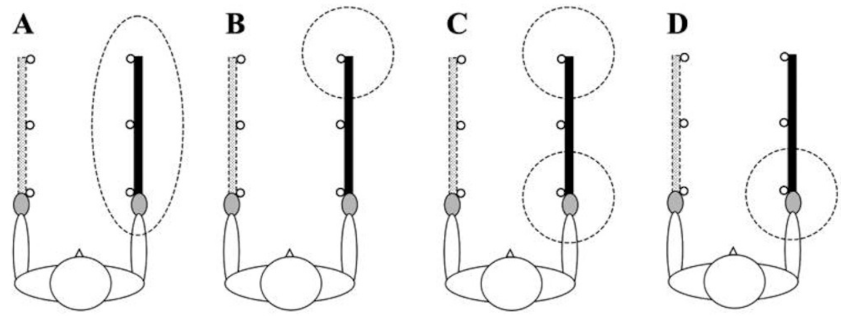


Figure 2.27: **Holmes and Spence, 2004.** A representation of the hypothetical areas of visuo-tactile neurological changes in peri-personal space, using dotted circles to highlight these zones schematically.

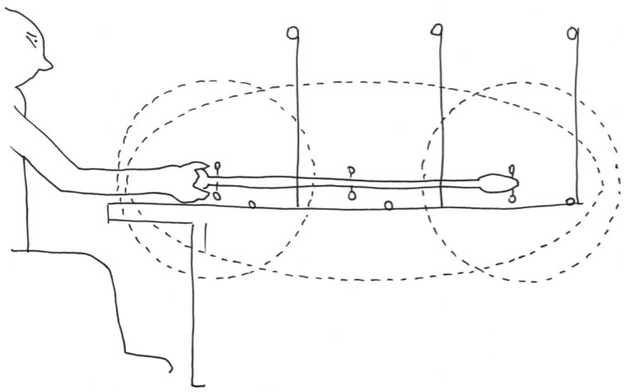


Figure 2.28: **Holmes and Spence, 2004.** A new peninsula of attentional space is created. Two of their published diagrams have been superimposed for this review, showing the hypothesised space-changes and experimental set-up.

2.2 Theme 2: shared space

How has shared space been represented in the literature on human interaction? Authors naturally address a wide variety of research questions, sometimes creating visualisations that have directly or indirectly pictured shared space.

2.2.1 Theory: projected spaces

Non-metric space relates to a variety of phenomena, including pointing (deixis). John Haviland describes how interactional spaces are framed by cultural and geographical spatial orientation (Haviland, 2000, and Haviland, 2005). He argues that pointing gestures are deceptively straightforward. They take part in and manufacture a 'multiplicity of gesture spaces' that are shifted between during an interaction. Pointing is a 'projected spatial context for an indexical sign,' pointing in the cardinal directions of the compass is a *narrated interactional space* embedded in the conversation for a period of time only (Haviland, 1996, p.23, his emphasis). This prevents the conversation from being permanently oriented in fixed directions, changing references for narrational purposes.

Haviland shows us that it is not always a matter of following the gesture with a gaze in an indicated direction, and addressees understand that the object or place referred to is out of sight in any case. The referent is therefore not always an object of joint attention, strictly speaking, but is more an object of peripheral attention. A pointing gesture can set up a narrated space that is not immediately present to view, and may not be correlated directly with the physical context.

There is a spectrum of pointing acts, from 'relatively creative' to those which presuppose an amount of knowledge about referents, says Haviland. He characterises referents as 'Peircean indices,' picked out by virtue of 'a shared spatio-temporal proximity' (p.18). Haviland accepts that gesture typologies require close attention (as Murphy does), and questions the assumption that pointing is a simple matter of proximal spatio-temporal indexicality.

2.2.1.1 ***Practice: projected spaces***

Gesture space surrounds the act of deixis, or pointing (Deixis1). The multiplicity of referents and the way in which these are layered, reflexively maps deixis itself (Deixis 2). This raises the question of how these layers can be represented with drawings.

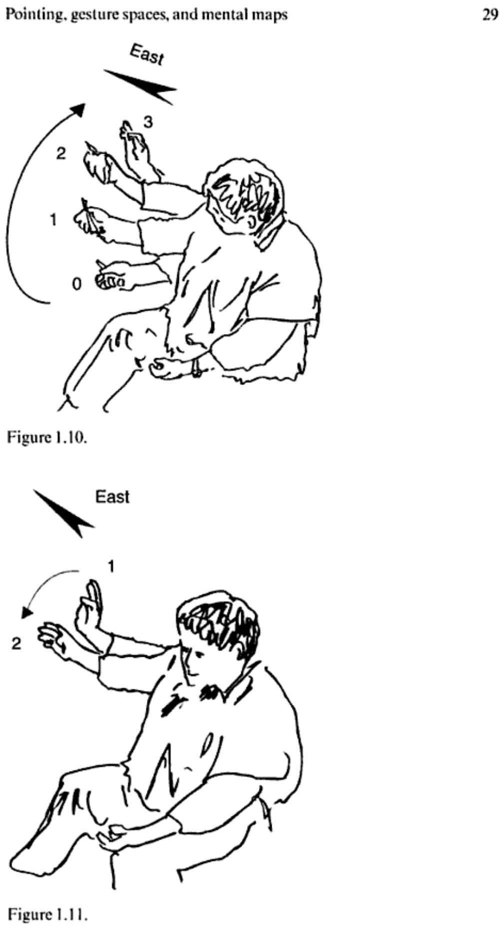


Figure 2.29: **Haviland, 2000.** Pointing towards towards the cardinal eastern direction, shown with arrows. Four stages of an arm swinging out are shown, subsequent states are shown 'under' the former ones.

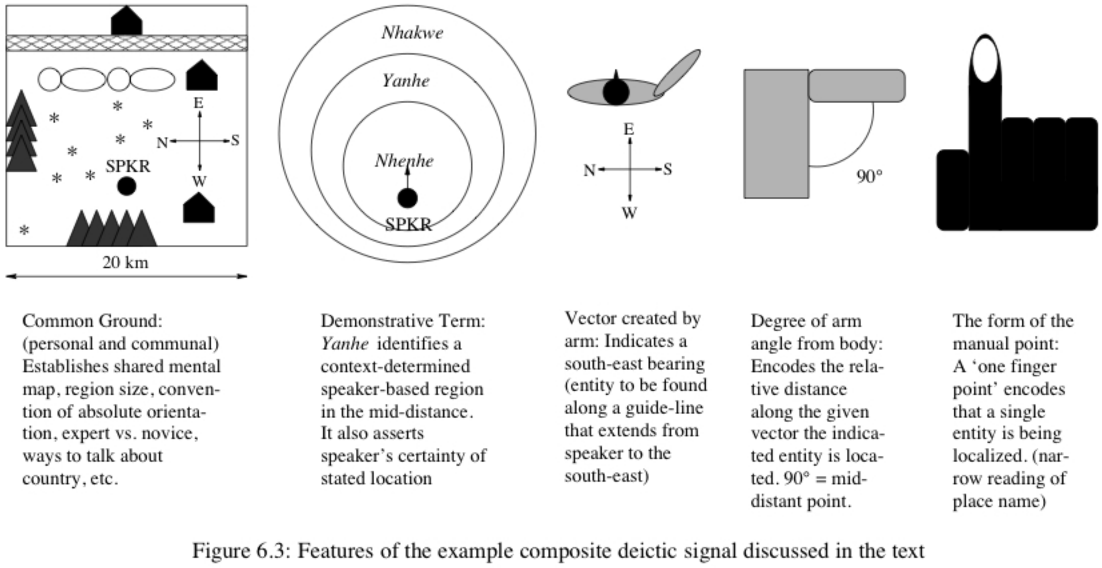


Figure 2.30: **Wilkins, 1999.** Views of the deictic frames of reference for geographic and local space, seen at different levels of detail.

English speakers generally use a relative frame of reference for gestures to represent direction. This is in contrast with a community in Queensland, Australia. There, an absolute frame of reference is most frequently used in both speech and gestures, a result of a different cultural attitude towards the land and one's position within it (Wilkins, 1999, Fig. 2.30). As Haviland mentions, these gesture spaces are rapidly layered over and replaced by new projections: they are 'complementary dimensions of projected spaces which can in fact be laminated one on top another.' Thus deixis and gesture space have an important intersection with cultural dimensions as well as being semantically loaded (or laminated) on occasion. These temporary formations of projected spaces discussed by Haviland, have something in common with the notion of the temporary construction of gestural models or maquettes that form part of a topology of interaction. Haviland's mention of these formations resonates with *Parallel Body Moves* (Gill, 2008), and with the synchronised and rapidly changing patterns of dance movement and cueing described by Forsythe and his animator collaborators (Forsythe, 2008).

Haviland describes pointing as being considerably more complex than the apparently simple matter of following 'the trajectory of your arrow-like digit' (Haviland, 2000, p.14). He uses a looser line-drawing style, with fluidly drawn marks for his gesturing people (Fig. 2.2.1.1). Cardinal points indicators are formatted in graphical software. This draws attention to the differences in kind between the people drawn by hand, and the movement and orientation values that have been attached to them. The effect of this is that the arrow visual aids appear to be inherently stable and text-like, and somewhat superimposed. In contrast the figures are drawn with dynamic hand-made marks. Treating content differently in this way is a reminder that these are interpretive drawings.

Kendon says that the introduction of 'a wholly new topic...is framed by a new arrangement in the *f-formation*' (Kendon, 1990, p.227). Changes in the configuration of the formation will not by themselves be sufficient to account for the qualitative changes within the interaction. When studying his plan-view diagrams of interactions, these changes in arrangements may alert us to when topics have changed for the interactants (Fig. 2.7).

2.2.2 Theory: 'visuo-spatial deixis'

Since at least the nineteenth century lines and arrows have been employed by researchers to represent deictics or pointing gestures (Mallery, 1881). In many cases this approach approximates interaction with drawing and transcript (Kendon, 2004). However, a straightforward 'arrow-like digit' (to repeat Haviland's phrase) will not be sufficiently adaptable to the purpose of representing the rapidly shifting indexicality of some interactions. A variety of lines and arrows are used to represent movement that has a deictic component by Haviland, Kendon, Efron, Goodwin and others (Bavelas et al., 1992). However, these researchers have not represented the non-metric plasticity of topically differentiated shared space. Nor have they explicitly visualised patterns of visuo-spatial deixis, or 'catchment' (with the possible exception of Efron, some of whose images relate to shared space). For a full typology please see Appendix. D.

2.2.2.1 ***Practice: 'visuo-spatial deixis'***

Kendon's are successful scholarly illustrations of interactions, augmenting text in ways that writing cannot follow, such as showing the origin, direction, context and extent of an interactional gesture. Kendon often uses hand-drawn and infilled tapering arrows (narrowing towards the head of the arrow). This is intended to convey sequence and speed, as well as direction (Fig. 2.32).

Mentioning the drawings only in passing, Kendon states that the representations are only intended to be 'immediately readable' for the purposes of illustrating the themes and observations that are elaborated upon in the body of his text, and that these are much less complex than the full transcriptions, which he says would be off-putting to the reader. Unfortunately, in common with McNeill and Duncan and many other writers, no example of a more complete transcription is given.

These drawings, made by Kendon himself, are 'drawn directly from images extracted directly from the video recordings.' He continues, 'It seems to me that such drawings are generally preferable to 'frame grabs'. Not only can one show, in the drawing, just the details that are pertinent for the exposition, but the problem of publishing photographs of people who might wish to remain anonymous is completely avoided' (Kendon, 2004, p.vii, Acknowledgements). This is an accurate appraisal of many of the drawings, as expositional devices without any pretensions other than to function in relation to his text (Fig. 2.34). Explications of the topic content that are related to these fluctuations in spatial arrangements are thus delegated to the body of the text and captions (Fig. 2.33). Stylistically, Kendon's use of line is free and easily readable, while the more developed graphical strategies that he uses are essentially the same as those that were used in the 1800's to portray the co-speech gestures of indigenous American peoples (Fig. 2.31). The main difference is the inclusion of an addressee in Kendon's drawing.

Gaze has a deictic dimension and this is reflected in drawings by the use of arrows to pinpoint addressees. Goodwin shows a dyadic interaction where the central standing figure looks out of frame, and a a dotted gaze-line represents that the central figure's gaze is averted from the seated gesturer who tries to capture her attention (Fig. 2.35). A second frame shows a mutual exchange of gazes (two lined-arrows passing each other in opposite directions).

The following was also obtained by Dr. W. J. HOFFMAN from Ta-ta^{n}-ka Wa-ka^{n}, before referred to, at the time of his visit to Washington.

I AM GOING HOME.

(1) Touch the breast with the extended index—*I*, (2) then pass it in a downward curve, outward and upward toward the right nearly to arm's length, as high as the shoulder—*am going* (*to*), (3) and when at that point suddenly clinch the hand and throw it edgewise a short distance toward the ground—*my country, my home.* Fig 303.

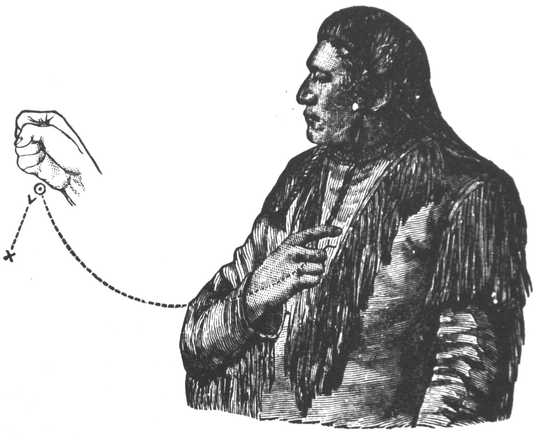


FIG. 303.

ANALYSIS.

Ma-ko′-ce		mi-ta′-wa		kin		e-kta′		wa-gle′		kta.
	(3)					(2)			(1)	
Country	||	my own	||	the	||	to	||	I go home	||	will.

Figure 2.31: **Mallery, 1881.** 'I am going home'.

Fig. 8.3a Example 5. Speaker moves hand outwards as he says "following my tail".

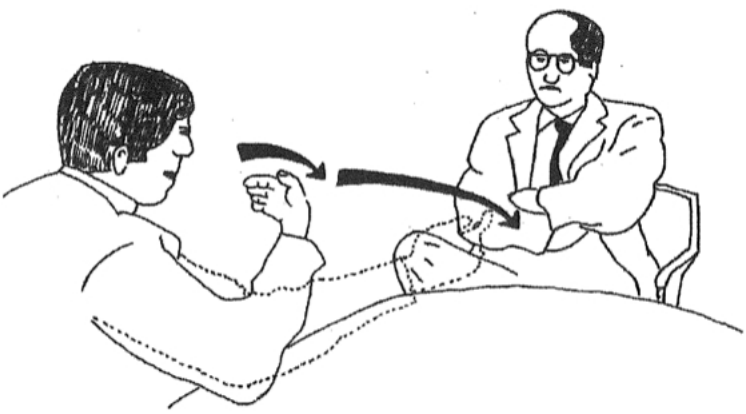


Fig. 8.3b Example 5. Speaker repeats with modification his outward hand movement as he says "following their tail". Note the greater degree of arm extension and lateral displacement as compared to 8.3a. Note also change in hand shape.

Example 5 Preceptor VII 2.37.89

```
I feel like I'm just FOLLowing my tail/ or (0.33) following THEIR tail/what they've
           |~~~~~*********~~~***|~~~~~~~***/********|-.-.-.-.-.-.|
             p       s1        s2   p      s1     s2        r
           [_____________________] [_________________]
                  fgp 1                   fgp 2
```

ALready initiated/ but I think we can we can (0.46) we can do something for her/ here today

Figure 2.32: **Kendon, 2004.** 'I feel like I'm just following my tail.. following their tail...'

On pointing 213

Fig. 11.9 Example 55 (Commerciante 00.08.14). Vincenzo playfully suggests that the two attractive young women filming them have remained a long time in doing so because Aniello is such a handsome fellow. He says: "*No pĕcchè hanno vistĕ Aniello nu bellĕ uaglionĕ!*" ('No because they have seen Aniello, a handsome fellow!'). He extends Open Hand Supine (palm up) toward Aniello, looking round at the film makers as he does so. He thus invites one to appreciate Aniello as a specimen of handsome manhood.

Figure 2.33: **Kendon, 2004.** The humorous situation calls for nothing other than the accompanying caption explaining the context.

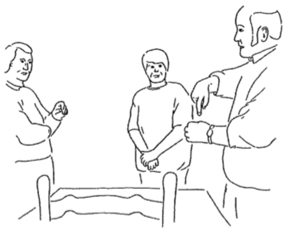


Fig. 9.5A M: "An' he got like ehm an auder an auger"

M's right hand models the instrument while his left hand models the cheese. The gesture is used here as a way of naming the instrument.

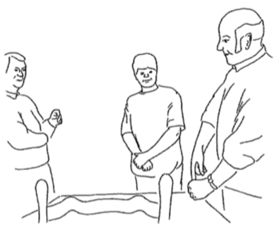


Fig. 9.5B M: "He'd put right down the middle"

M plunges index finger into the fist of his left hand, lowering both to the table as he demonstrates the action of boring into a cheese with an auger.

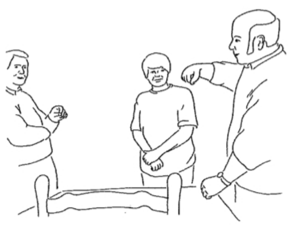


Fig. 9.6C M: "and take a bit out."

Right hand is lifted up. Note the change in hand shape to a shape one would use when holding the handle of something. M enacts pulling the auger out of the cheese.

Figure 2.34: **Kendon, 2004.** Multiparty interaction is drawn here with no arrows or other graphic devices.

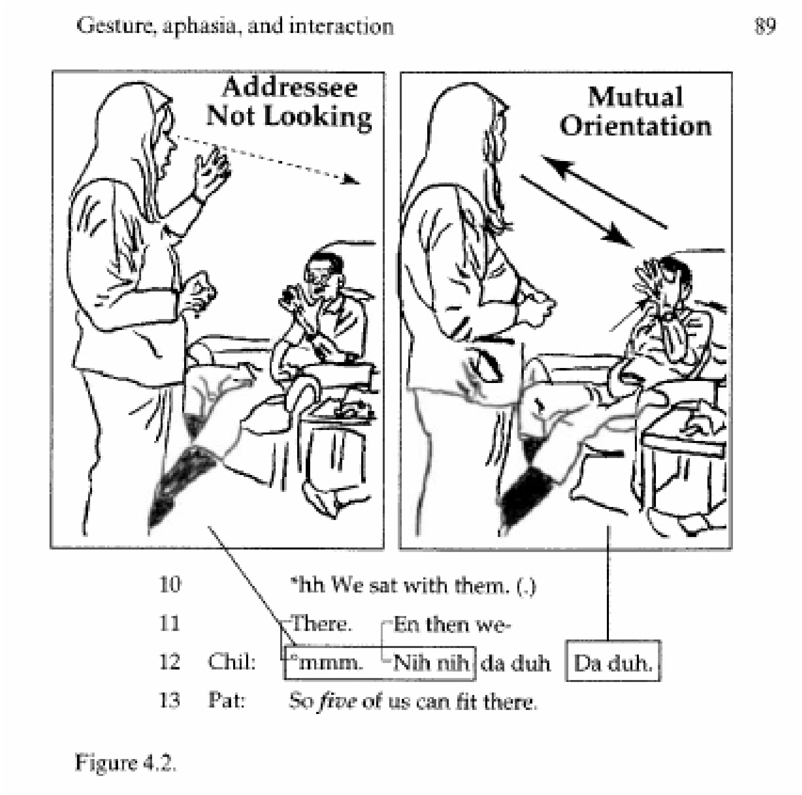


Figure 2.35: **Goodwin, 2000.** Multiparty interaction, from 'Gesture, Aphasia, and Interaction'.

2.2.3 Theory: time in sign-space

Research in sign-language usage has invoked the concept of 'signing space' (Crystal, 1987). This concept has also been generically applied in other areas of interaction research to mean topical or gesture space (Emmorey and Reilly, 1995). The examples reproduced in the following section demonstrate temporality in sign-language, assigned to relative positions along spatial axes. For example, a horizontal line or plane is shown passing near the signer's ear and cheek, and is used to express time relationships that stretch from the past (behind), to the future (forward) (Frishberg and Gough, 1973, reproduced in Kendon, 2004). The gestural mapping of time is most often discussed without reference to whether and how this has been jointly managed in interaction, because of the assumption that addressees will understand the conventions and usages fully.

When it comes to the coding of data, establishing on which axes a referent has been placed is of paramount importance. Sign-space schemas are smaller than those described by McNeill, but at the same time are more dimensional. The up-down and forward-backward axes are divided into left and right halves in which to sign (Klima and Bellugi, 1979, Fig. 2.8).

2.2.3.1 ***Practice: time in sign-space***

Diagrams of time in sign-space tend to be schematic and untethered to specific data (Fig. 2.36). These drawings show the topics from a narration of a cartoon narrative. These are placed relative to each other in top-view only. The drawings do not depict the relative vertical or temporal positions of these topics, or the location of an addressee (Fig. 2.39, and 2.38).

Emmorey reproduces a top-view schema diagram of anaphoric, deictic, and sequence time-lines. Three axes cross gesture space: the sequential time-line moves from right to left, while the deictic time-line moves from back to front. A further diagonal axis is added to Emmorey's diagram, which has been appropriately visualised in top-view. This accounts for the use of anaphoric time-lines in dialogue (Fig. 2.37).

Emmorey's drawing takes account of added dimensions, with the exception of the vertical dimension, and it is possible that signing could produce examples of time-lines that are a combination of these dimensions. Her diagram is accompanied by a time-series of panels showing frame-grabs from video data, revealing the use of the deictic axis in sign space while also plotting the use of the vertical axis. Compare this to Bacon's diagram (Fig. 2.2) where points of interest on the exterior edges of the spherical gesture space represent another view of topic space.

Signers and other speakers occasionally need to refer back-and-forth to the same or different items, and in doing so they trace a time-line in the space around their bodies. This expresses diachronic time (meaning 'across time', rather than of the moment). While the drawings shown here succeed in mapping out the points of interest in schematic terms, they do not succeed in terms of showing the dynamics. Compare the effective use by Efron of ribboned arrows to convey spatial as well as temporal placement (Fig. 2.18).

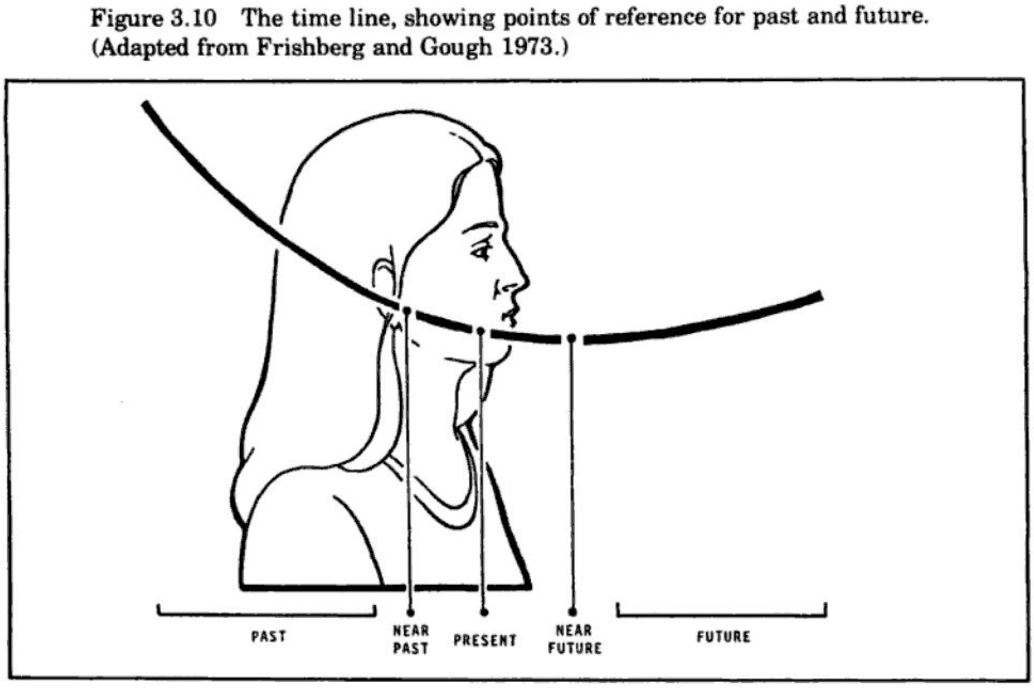


Figure 2.36: **Kendon, 2004.** The time-line in sign-language. This image comes from an unpublished manuscript (Frishberg and Gough (1973)). Topics are assigned a position along a spatial axis that denotes time.

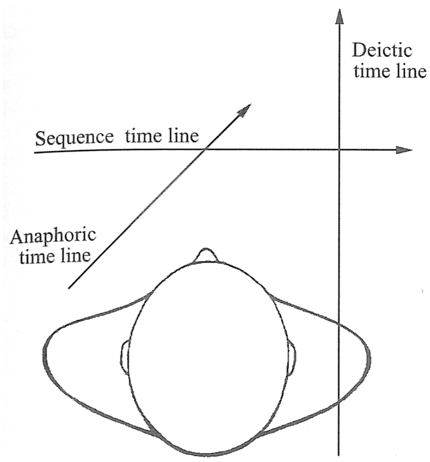


Figure 2.37: **Emmorey, 1995.** A top-view schema of anaphoric, deictic, and sequence time-line.

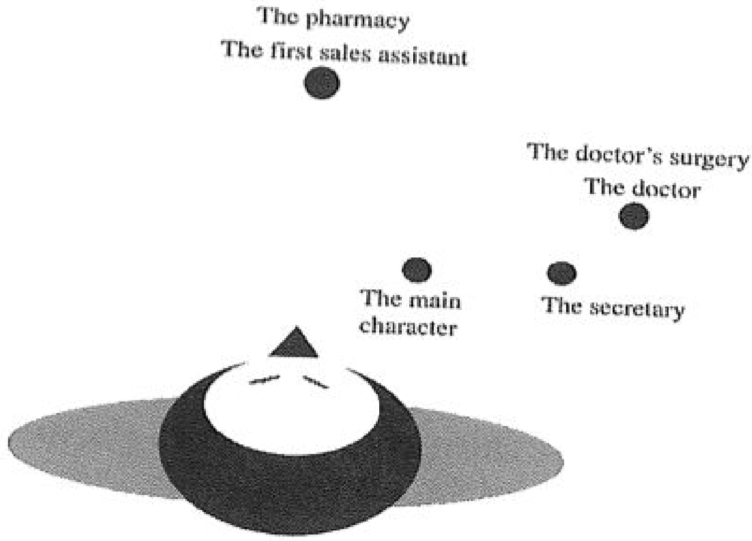


Figure 2.38: **Kendon, 2004.** From Poizner et al., 1990. Narrational topic space without temporal sequencing.

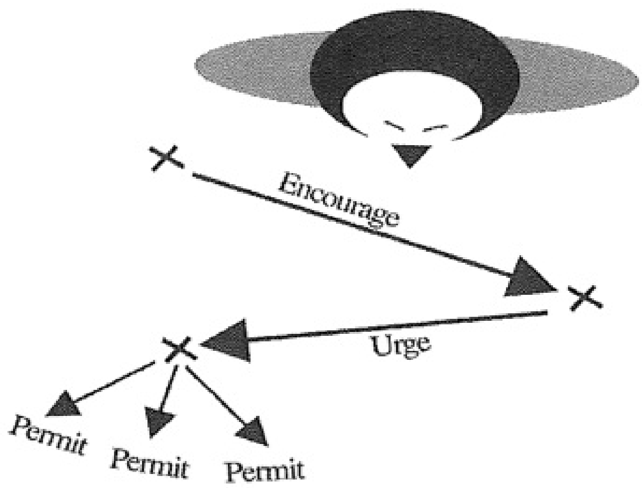


Figure 2.39: **Kendon, 2004.** From Poizner et al., 1990. Actions in topic space with temporal sequencing.

2.2.4 Theory: ‘deixis am phantasma’

Deixis is often be cited as a defining characteristic of gesture space, as discussed above. Deictic phenomena are presented in the context of an analysis of ‘Deixis am Phantasma’, or of referents that are not physically present to the speakers (Fricke, 2003). The drawings represent the placement of topics by one party during dyadic interactions.

*2.2.4.1 **Practice: ‘deixis am phantasma’***

An arrowed drawing can, on close inspection, fail to provide in-depth information about deixis. Printed on the page, a drawing can at best help us to make an educated estimate about hand position and its connection with co-speech, on the basis of relative positions of other participants and objects in the scene. This estimate will depend on the spatial relationship between the gesture vector and the position of the camera that has captured it. It also depends on what is in the line of vision behind the arrow, potentially confusing our view of the scene. Ambiguity or possible confusion could arise (Fig. 2.40). There are no cues to inform us precisely if the hand and arm of the person on the right is suspended in mid-air, as we might assume from the interactional context, or if it is touching on the arm of the addressee behind.

Other drawings from Fricke show shared space that has been delineated by speech and deixis, by the use of a dashed-line shaped elliptically. In one case it is placed horizontally on the table-top between speakers (Fig. 2.41). In another case it is oriented vertically at the end of an extended arm: the top of the shape touches the lower part of the hand of an extended pointing arm (Fig. 2.42). This may be intended to be the part of the moving hand that is tracked by the dashed ellipsis, indicating the region where the arm waves during the gesture. This elliptical shape represents either an actual arm movement, or an abstraction from a range of movements that summarises them visually. The interactants themselves are drawn in solid line.

272 5 Das Raumproblem

hier/ (.) die Straße/ (.) die Ampel (.) bist auf der andern Seite (..)]$_2$ ^{3}[und **hier** überquerst du dann wieder\]$_3$

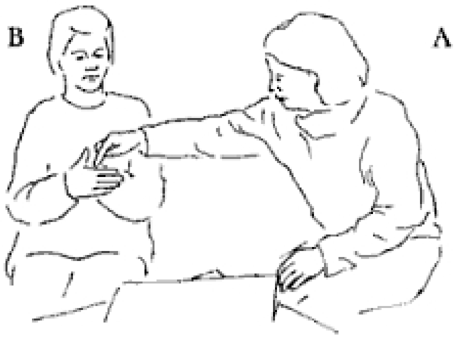


Abbildung 117: Die gemeinsame und simultane Erzeugung des deiktischen Verweisraums in Beispiel (134) (Geste 1)

Abbildung 118: Die gemeinsame und simultane Erzeugung des deiktischen Verweisraums in Beispiel (134) (Geste 3)

Figure 2.40: **Fricke, 2007**. This image shows two stages of a localised pointing gesture above the table in front of the dyad, where A's hand draws a short line horizontally in the air.

(129) A: [**hier iss das Bächlein/ (..)**]

Abbildung 109: Kartenähnliche Modellbildung

Figure 2.41: **Fricke, 2007.** A circular topical space is inscribed gesturally upon the horizontal surface of the table between two people.

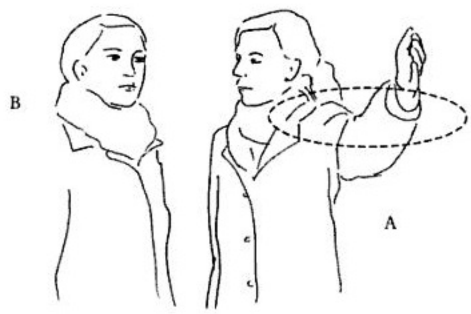


Abbildung 106: Einbettung eines kartenähnlichen Modells
im dritten Hauptfall der Deixis am Phantasma

Figure 2.42: **Fricke, 2007.** A spatial region is deictically indicated, an upright oval or possibly a horizontal circle is described by A's gesture.

2.2.5 Theory: 'imaginary three-dimensional space'

Murphy describes 'track' or 'tracing' gestures, linear and directional hand movements referring to locations on architectural drawings during collaborative meetings. These gestures are instrumental to ‘construct and manipulate an imaginary three-dimensional space’ using the media available to them: talk, gestures, pencils, and architectural drawings (Murphy, 2003, p.139).

In a later paper his approach has shifted towards an ‘augmented’ situated cognition perspective where the decisive points in the interaction are distributed over these many media-based ‘nodes’ (Murphy, 2005). Gesture is one of the vehicles that combines ‘external semiotic media’, such as the drawings and plans, to create meaningful ‘intersections’ among them. At these intersections are situated ‘imaginary things’ that have been given a role in social space (Murphy, 2003, p.140). These are what we would ordinarily call the proposed design alternatives.

Gesture and speech, in this view, form ‘a single semiotic unit,‘ containing all of the imaginative aspects of the architect’s discussion. This he says, makes current gesture classifications unequal to the task of describing these units adequately (Murphy, 2005, p.44). Murphy’s approach is to map the jointly used physical space onto linguistic events. By contrast, the McNeill laboratory’s gesture space schema maps semiotic and linguistic relationships onto the physical space around a person (showing only one or two of the many semiotic dimensions that are available) since they are not dealing with gestures that participants make in elation to working architectural drawings and plans.

Murphy’s analysis identifies gesture space with the interaction that forms it. He looks at speech and gestural vectors that have a framing effect on the space, calling these ‘intersections’. These nodes can be compared to ‘topic spaces’ (Healey and Peters, 2007, and Battersby, 2011). These are points significant within the interaction, where speech, gaze, gesture, posture and objects coincide meaningfully. It is not clear why he has to call this an ‘imaginary three-dimensional space’, except as a shorthand means of distinguishing a potentially non-contiguous interactional space from that of the physical room that the architects are sitting in. A fuller depiction of it is a task that has been left aside, or left to the reader to imaginatively reconstruct for themselves from his blend of transcript, thumbnail images, plans, and outlined hands.

2.2.5.1 ***Practice: 'imaginary three-dimensional space'***

Murphy states that his arrows and lines are 'drawn to clarify the span of some gestures or the path of some gestures' used by the architects in his study (Murphy, 2005, p.142, Notes). The transcripts are clearly set out with Turn numbers, proper names, and notations for speech overlaps, emphasis, and pauses (Fig. 2.43). Gesture strokes of interest are highlighted with boxes around the associated text. These boxes are intended to unify the images and transcript.

Murphy's panels show the scene in a number of perspectives, including plan views and different angles upon the topic spaces (and detailing the original architectural drawings). This is a graphic development upon the source footage. As with Kendon's overhead views, he appears to extrapolate a different view from a single camera.

Murphy represents the plans as a three-dimensional plane over which the interaction occurs. He takes care to index gestures to spatially contextualised drawings. Textual descriptions of hand movements are more detailed in Murphy's transcripts than in McNeill's, for example, with specific references to where on the plans hands are pointing. In one case, the thumbnail-sized video frames provide a context for where figures are seated. This provides some appreciation of trends in the larger movements (Murphy, 2005, Example 2, figures 4-8). *Fragment 2* includes the description 'raises hand near head, moves back and forth.' Smaller subordinate images require the use of identifying numerals to which greyscale images they are intended to refer to (Fig. 2.44).

Murphy tends to represent the architect's gestures with the appearance that they are planar. The architects are possibly creating a gestural ellipsis of complex spatial problems, summarising the problem space into up-and-down and left-and-right flat-handed gestures. This is certainly reflected in Murphy's representations.

How successfully do these representations manage to delineate the detail of shared spaces? In *Fragment 6* the silhouetted hand has a shape and orientation in relation to the printed plans on the table, but does not so easily disclose its position in space relative to the hands of others present (Fig. 2.43). A primary figure is shown, and the silhouetted hand combined with the frame from the video makes it is possible to obtain an impression of the general scale and direction of movement. For example, to gain an understanding of how high the finger is above the sheet and table. This is sufficient for the type of spatial analysis of semiotic 'intersections' undertaken by Murphy. The introduction of alternate perspectives into these representations makes it possible to show the inverted cupped-hand, which would be difficult to show outlined as a silhouette.

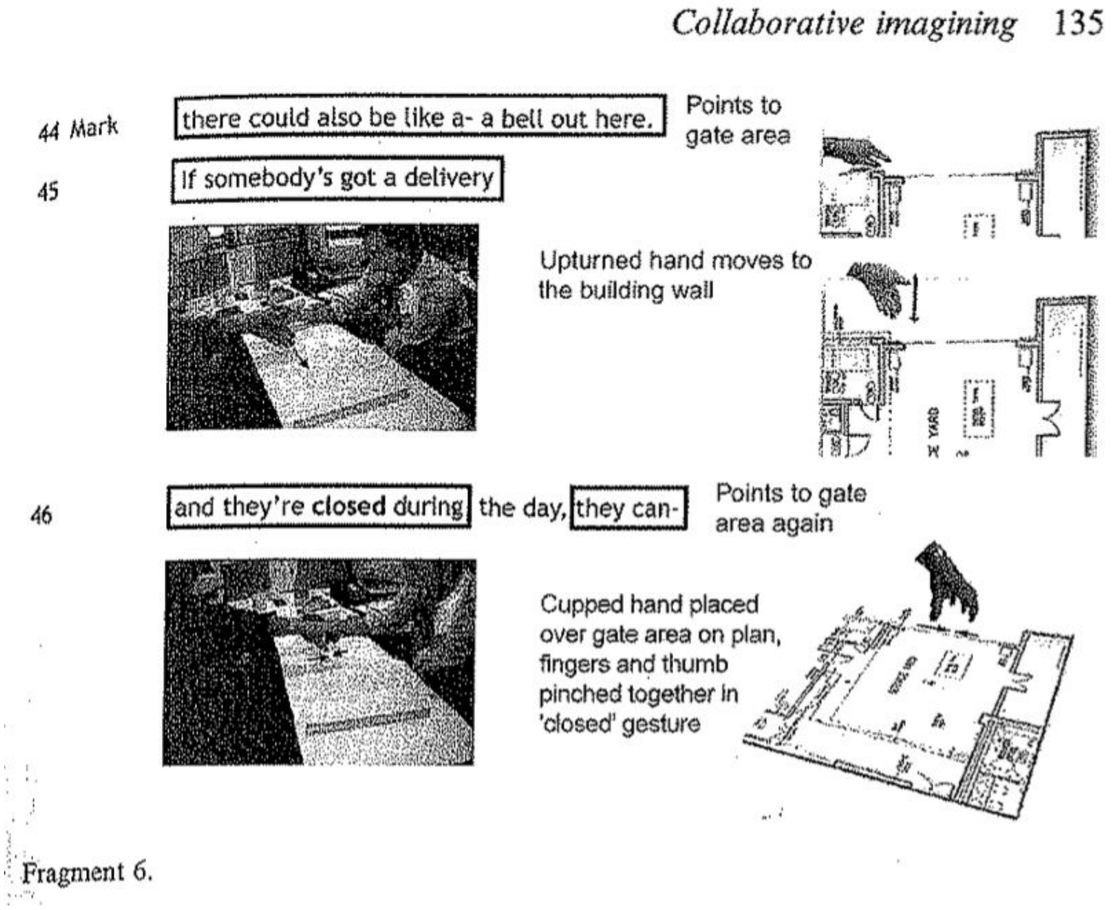


Figure 2.43: **Murphy, 2003.** Architectural meeting, with plans, in frame-grabs and line drawing.

<u>Example 2</u>

2.1 Julie so that door was kind of-

2.2 George Sure.

2.3 Julie $\boxed{(1.0)}$ J. traces path with index finger

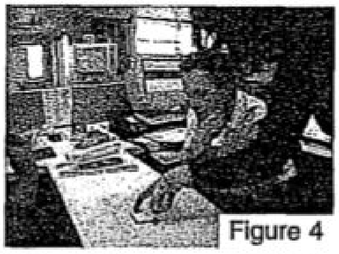


Figure 4

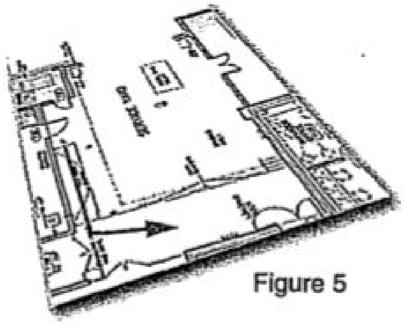


Figure 5

2.4 George $\boxed{\text{So everybody comes around that}}$ way

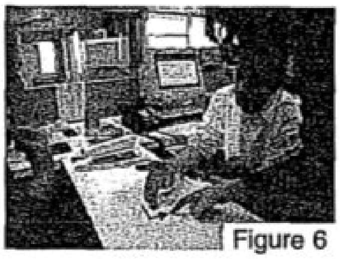


Figure 6

G. follows J's trace traces path with index and middle fingers

2.5 [I see. Of course. Of course.

2.6 Mark [Right. Right.

2.7 Julie [And-

2.8 Mark [You can (panel) trucks that pull in.

2.9 Most of their stuff will just be

Standing at the entrance M. follows G's trace with pencil

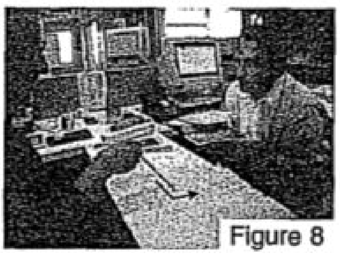


Figure 8

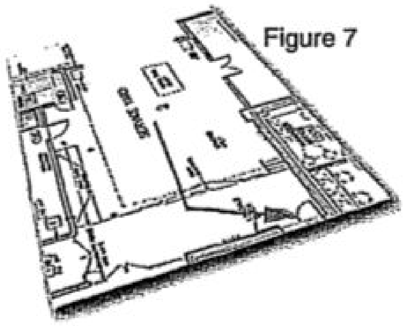


Figure 7

2.10 carted right in there.

Figure 2.44: **Murphy, 2003.** A bird's eye view of the drawing on the tabletop.

2.2.6 Theory: 'topographic space'

In some cases, researchers have needed to schematise the specific content of qualitative space in order to present their results. Emmorey pictures shared space in schematic terms in order to classify the three types of relationship between speaker and addressee (Fig. 2.46). She addresses 'semantically loaded' gesture space in an experimental signing subject with right hemisphere brain damage (Fig. 2.45).

2.2.6.1 ***Practice: 'topographic space'***

Emmorey's representation was adapted from earlier authors (Poizner et al., 1990). The drawings show a figure in three-quarters view with a semi-circular sign-space arranged frontally and horizontally. This places the 'loci of the movement' within signing space directly in front of the subject's chest, and this type of schema has been discussed previously under body-centric representations of gesture space (Klima and Bellugi, 1979, Fig. 2.8, part A). The room described by the subject has been displaced to the right side.

Emmorey uses a demi-sphere gesture space schema in front of a sign-language user. The schema creates the appearance of a horizontal table in front of the signer, a semi-circular platform for communication. This is designed to facilitate the analysis of signing by dividing the shape into left and right quarter-spheres from eye-level to waist. In this way left and right handed gestures can be categorised, as well as showing the degree of forward motion. Here, the schema is put to use in order to show the slanting of the subjects's perceptions towards one side. In the context of this empirical data and also of schematised overhead views (Fig. 2.46), the schema shows orientation towards an addressee, and is a reasonably adaptable if basic template for shared reach-space.

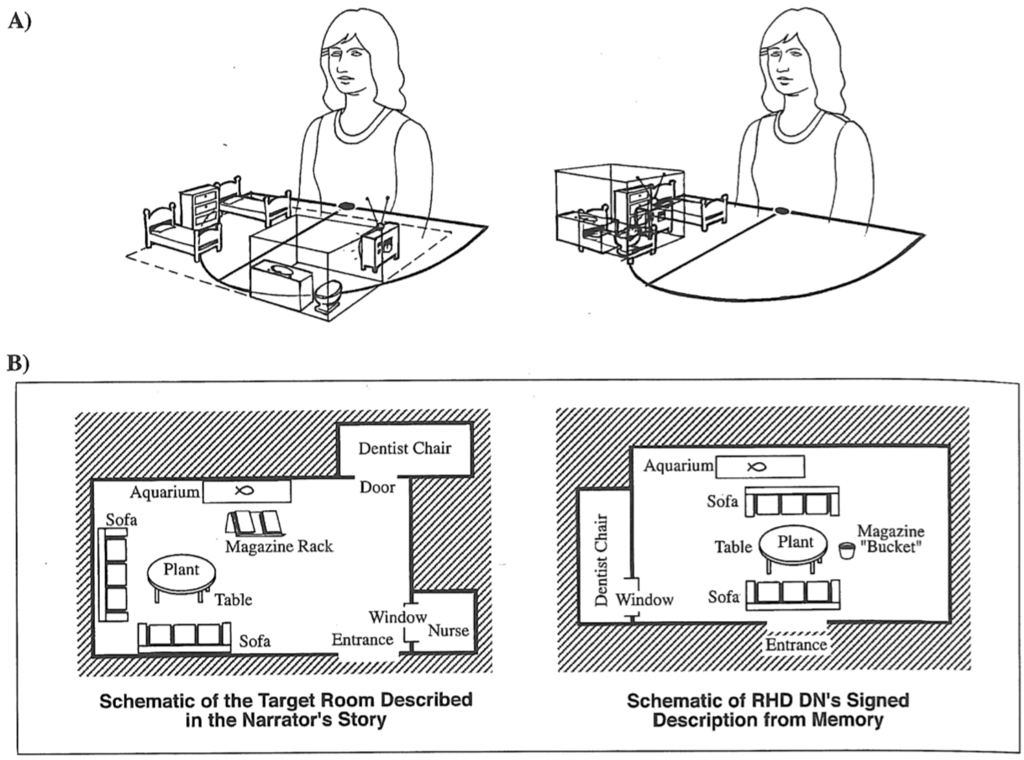


FIG. 9.8. Illustration of the breakdown in the use of topographic space following right-hemisphere damage. A) A schematic of RHD signer BI's spatially distorted room description (from Poizner, Klima, & Bellugi, 1987). B) Schematic of RHD signer DN's retelling of a spatial description (adapted from Emmorey, Corina, & Bellugi, 1995). Illustrations copyright © Ursula Bellugi, The Salk Institute.

Figure 2.45: **Emmorey, 2002.** A representation of distorted qualitative space. The outlines of the reduced-scale items of furniture act as stand-ins for the remembered room and its contents.

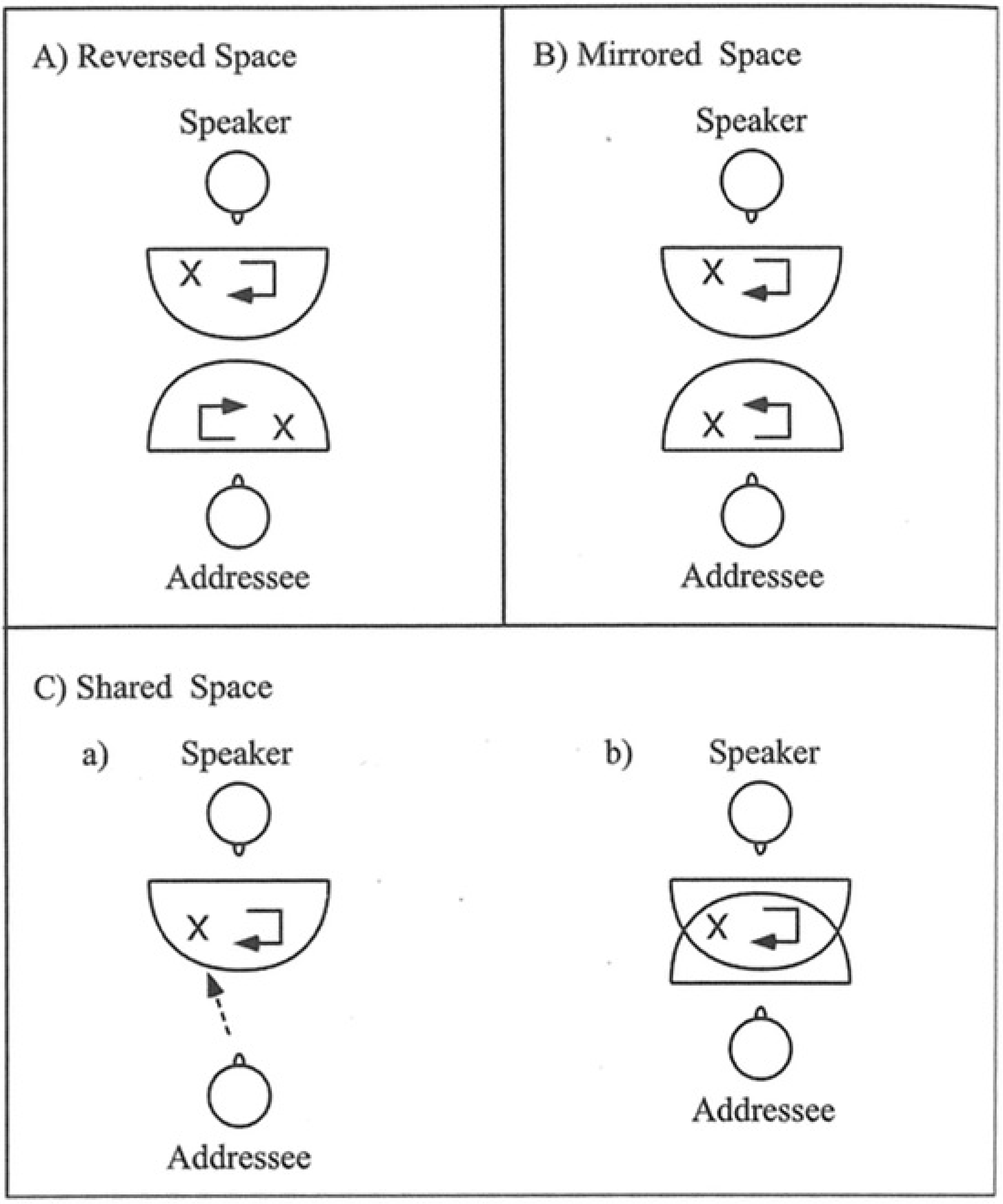


FIG. 3.12. Illustration of A) reversed space, B) mirrored space, and C) two examples of the use of shared space for nonpresent referents. The half circles represent signing space, the solid arrow represents the direction of the Maple Street loop, and the "X" represents the location of the town hall with respect to Maple Street. The dotted arrow in example (a) of C) indicates the direction of a pointing sign used by the addressee to refer to the town hall.

Figure 2.46: **Emmorey, 2002.** Diagrammatic representations of shared space, employing a demi-spherical model of gesture space.

2.2.7 Theory: ‘VolumeViewer’

Studying the ‘choreography’ in interactive gestures within a group of three seated Angolan students, Rodrigues visualises their overlapping personal and gesture spaces (Rodrigues, 2010, Fig. 2.47). Software extracted gestural movement from video as a series of static ’silhouettes’, and rendered these as a stacked three-dimensional volume with time added as an axis. This tool creates the means to make observations as well as the means of representing findings. These visualisations appear to be three-dimensional, but in fact display two-dimensional frames arranged in front of each other. This succeeds in conveying a textured patterning that points to the spatial depth and dynamisms of her data. The software[2] is theoretically able to display data with transparency, in a number of different spatial arrangements, countering the potential problem of occlusion of parts of the data.

[2] *VolumeViewer* is an interactive tool for ‘fitting surfaces to volume data’, in order to ‘to improve the overall accuracy and efficiency of the segmentation and segmentation review processes’. See: http://volumeviewer.cse.wustl.edu/VolumeViewer/Home.html

2.2.7.1 ***Practice: 'VolumeViewer'***

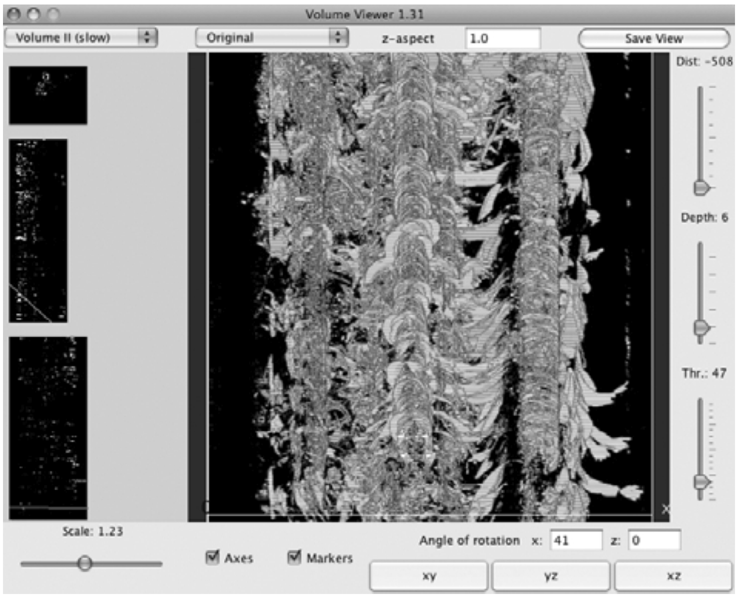


Figure 2.47: **Rodrigues, 2009.** Angolan students use of gesture space visualised as a topography with 'VolumeViewer.' The caption reads: 'the sequence is then viewed as a 3d volume to reveal the shared gestural space.'

Rodrigues states the need for flexible definitions of personal space, gesture space, and interactional space. Her visualisation of shared space does not represent topical space. If the vertically displaced stack of data was subjected to a further pass of interpretation, it might have been possible to begin to differentiate the topologies. The data is described in evocative topographical terms that are not commonly found in the literature: 'Three fairly stationary heads form three ridges, with the rhythms of arm motions between the figures appearing as a texture in the furrows' (Caption to figure 7, p.30). A topographical analogy is also used in peri-personal space research, where new peninsulas or islands of attentional space are manufactured during tool-use (Sect. 2.1.5.1, Fig. 2.28).

2.2.8 Theory: instructional gesture space

Mathematics and physics might seem an odd place to look for paradigms of shared space but the use of gesture space to deliberately communicate mathematical concepts has been proven to be an effective instructional approach and yields concrete examples of shared space as a qualitative phenomenon.

2.2.8.1 ***Practice: mathematical gesture space drawing***

Adding drawn marks to video stills to understand this use of topical gestural space, is a graphical strategy used by researchers interested in the deliberate differentiation of gesture space as seen in mathematical teaching (Yoon et al., 2011). A shared production of meaning occurs in jointly maintained and conceptually 'endowed gesture spaces', referencing work elsewhere (Goodwin, 2000). This representation improves upon previous attempts to show jointly used space, for example the blackboard and gesture in the teaching of physics (Ochs et al., 1996, and Gonzales et al., 1994). The inherent spatiality of the mathematical case lends itself to a richer visual description.

Yoon shows the graphs under discussion as they are being drawn out gesturally, above the table where teacher and pupil interact (Fig. 2.49). The content of the discussions is given as superimposed lines in white and black, added to video frame-grabs. This has been achieved with the use of image manipulation software (*Photoshop* for example), where a 'pencil' line of a few pixels width is drawn in the appropriate areas. Alternatively, a screen capture from the video is made with software including tools for adding text and shaping vectors ('Grab' on the Mac platform or 'Snipping Tool' in Windows, for example). These tools enable quick and effective inscriptions to be made directly onto a digital copy of the data, although they are restricted to the resolution of the screen-shot.

Yoon et al. use the Grounded Blend model of Liddell, as do Parrill and Sweetser, developed in the study of sign language. This relies upon conceptual 'Input Space' as one of the compo-

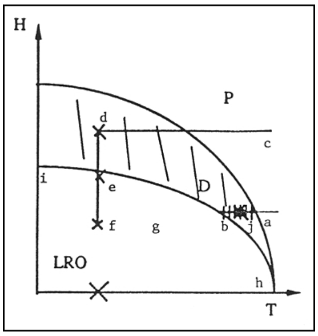


Figure 2.48: **Ochs et al., 1996.** Physics instruction gesture space, a reconstruction of the sub-space drawn upon the blackboard and shared by the teacher and student.

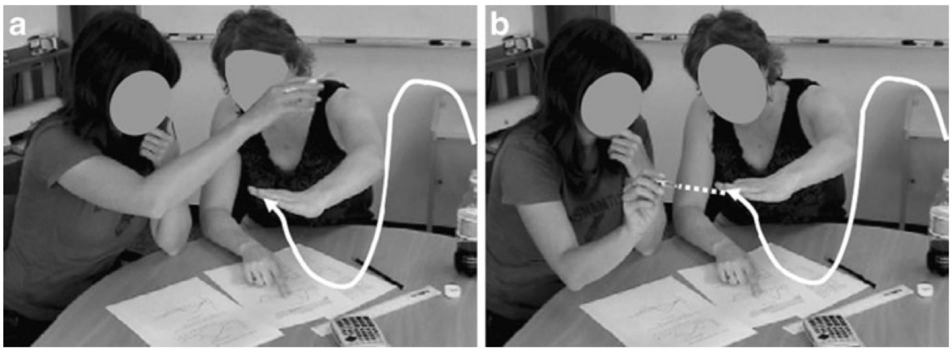


Fig. 10 **a** Ava points to the virtual anti-derivative graph Noa has created. **b** Ava extends Noa's virtual anti-derivative graph

Figure 2.49: **Yoon et al., 2011.** Mathematical teaching with the use of gesture space, shared by teacher and student. This was reproduced next to photographs of the teaching interaction.

nents that produces a blended space in gesture, contrasted with 'Real Space' (also used by Parrill and Sweetser). The theoretical separation between real and input space is related to two modes of representation; the anonymous photograph (with faces obscured), and the digitally inscribed marks over the photographic still. They show one case where a teacher's gesture describes the line of a graph, and the pupil continues the line. The former is shown as a solid-arrow line, while the latter is tentatively dashed (with no arrow) line. Judging from the screen capture there will have been other gestures that are not shown, but which will have been important to framing this particular interaction, such as the raised arm of the pupil in the first frame.

2.2.9 Theory: shared space as gesture completion

Below are described a number of cases from the literature where shared space has been characterised as that which is jointly constructed in gesture space. The first concerns origami instruction, the second relates to mathematical instruction, and the third describes collaborative architectural meetings. In the background to this is the notion of referencing 'common ground' (Clark et al., 1983, see Sect. 2.2.12).

2.2.10 Theory: origami instruction

We have seen how Yoon et al. have designed a part-drawn representation of a gesture completed by another person. Furuyama describes an experiment where two people work upon an Origami task, and the instructor's gesture is taken up and completed by the learner (Furuyama, 2000). He concludes that the two collaborative gestures have combined to form a *joint unit* in gesture.

Furuyama's experimental procedure was as follows. Eighteen students were divided into pairs, in which the more experienced student was required to instruct a fellow student in the construction of an origami balloon without using paper to help them accomplish this task. The presence of an addressee is a key development here. The pairing of lesser and greater experts in origami, is a refinement on the subject-observer paradigm.

The origami expert has been given the task of describing methods for folding paper, but without the use of an actual square of paper, and explains why the ‘virtual square’ has to be manufactured by the interactants. The complex foldings have to be demonstrated without the use of paper: ‘For example, one can say, “This is a square piece of paper” while tracing a square in the air with an index finger’ (p.72). This virtual square is a continuing factor in the discourse with one of its corners being pointed at and referred to as ‘the upper right corner’. This relative term reveals the shared perspective upon the square. This point of view is indexically ‘entailed’ by all of the speech and gesture that follows, according to Furuyama.

‘Indexical unity’ is identified with the ‘poetic structure’ of discourse. His analogy is with weaving, in that each of the two types of sign (speech and gesture), correspond to two types of threads: ‘the vertical and horizontal threads that interweave one piece of fabric which we call a discursive textual structure.’ He describes this as ‘the plane of discourse’, across which poetic structure is distributed. ‘Poetic’ should here be taken to mean the intuitive and creative ways in which speech and gesture forges connections between different strands of deixis. He says that ‘indexical unity is the horizontal threads and poetic structure the vertical ones’ (Furuyama, 2000, p.74).

Furuyama’s ‘spatiotemporal contiguity between the sign and its object’ becomes problematic when applied to non-contiguous topic spaces, of the kind that occurs in collaborative interactions (Chapter. 3). The proposed ‘chain of entailment and reference’ (based on ‘indexical unity’) tangles when a topic space is evidently projected onto the physical setting in several different ways, as occurs in collaborative settings where space is manipulated. The re-structuring of situated interpretations threatens to significantly complicate the appealing notion of horizontal ‘threads’ that unify.

The origami-folding experiment is an attempt to account for the spatiality of interaction. Furuyama’s goal is to apply theoretical ideas to ‘between-person’ coordination. He says McNeillian Growth Point theory ‘was a theory that was originally developed to explain within-person gesture-speech coordination’ but has in his work been applied to dyadic interaction (p. 349). This endeavour is based upon an assumed spatio-temporal contiguity between signs and their

(7) L: (A) {<u>and you take this corner*</u>}

The learner, extending her left hand between the instructor's chest and his gesture, picks up and moves the upper-right corner of the tringle downward, as previously rendered by the instructor. This is shown in the still image with timecode 00:29:37:22.

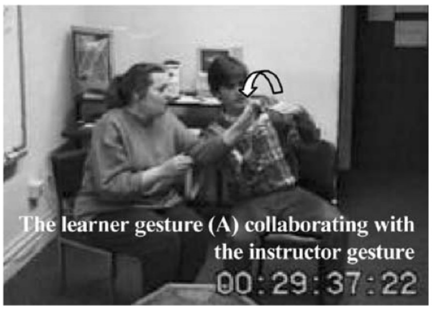


Figure 2.50: **Furuyama, 2000.** Origami instruction and gesture space, shared by expert and learner.

objects.

*2.2.10.1 **Practice: origami instruction***

Furuyama uses a small video frame-grab with an arrow added digitally, with black outline (Fig. 2.50). Representing simultaneity is not a straightforward matter, and here an arrowed photograph offers an immediate way to indicate a general type of movement. A learner, in the third example, is observed as she 'picks up and moves one of the corners of the imaginary triangles gesturally rendered by the instructor'. These are described as collaborative *gestures that are jointly produced* in the sense that they *are produced in the space between the instructor's chest and this gesture, almost on the gesture* (Furuyama, 2002, p.356, his emphasis). There is a synchronised simultaneous movement: she almost touches his hand as he makes his explanatory gesture at a slightly later moment. Furuyama does not represent this interaction in more detail, possibly because a drawing for example, could not add anything to the textual descriptions. The richness of the textual descriptions of these interactions suggests that an opportunity to visualise the literal folding of interactional space was missed.

2.2.11 Theory: 'virtual gestural maquettes'

What are the defining features of an interaction that utilises spatially distributed topic spaces? This question is investigated by Healey in the context of meetings observed at an architectural practice in London (Healey and Peters, 2007). The stated units of analysis and analytic categories are: turn-taking, joint focus of attention, and 'virtual gestural maquettes', implemented jointly by the architects, and topic space (defined as a space that has been differentiated by its relationship to a topic within the interaction).

An example of a speech-turn that sets up the comprehension of a gestural maquette is given by Healey: 'connections through the basement then up into the building' (Turn 038), is designed to integrate two drawings into a single representational space for that moment. This provides the architects with a 'richer more heterogeneous topology' to work with. Excerpt 038 for example is evidenced by Clip 3 in the corpus (Date: 13/6/2000; Source: Video 13-6-00 tape B). This corpus is the basis for the Case Study (Chapt. 3).

Gestural maquettes are joint units in Furuyama's sense, where one person's gesture is completed by another. They can be supported by, and added to, by other gestural contributions. In common with Murphy's 'imagined objects', they are the points through which the interactions are given coherence and cohesion. This is achieved by indexing the speech-turns to the paper spaces. It is evident that visuo-spatial gestures support mutual understanding when exchanges of gazes would be distracting from the task at hand. Gestures can therefore help to sustain the momentum of the dialogue, removing the need to look away from points of shared design interest.

Healey observes that 'those aspects of the topology that are contingent upon access to the shared interaction space are more important for multiparty dialogue' (Healey and Peters, 2007). This is established while focussing on the units of speech, gesture, and other media used in the workplace. Healey and Battersby's identification of gesture and its co-speech as embodying a set of related places within an interaction, or a topography of interaction, could be compared to Efron's statement that gesture can serve as a 'logico-topographical' diagram of thought. However, in this case the topography of 'places' that are thematically linked together are seen to originate in more than one person and to come about through their interaction (Battersby et al., 2008, and Healey and Battersby, 2009).

Healey and Battersby examine how shared space enriches the semantic possibilities within interaction, finding that collaborative modification of gestures occurred as a result of motion-captured three-dimensional shared space that exists between participants.[3] They conclude that referential spaces are created that can be used deictically as topical reference points within the conversations. These are known as 'topic spaces,' or qualitative spaces.

2.2.12 Theory: 'common ground'

Looking for evidence of interactive gestures being designed for recipients, Özyürek employs a cartoon narration task format for experiments with her subjects. Her experiment is designed to reveal what the 'common ground' is held to be by the participants themselves. The notation of 'Across', for instance, is given as a passage of movement from one side of gesture space to another that is on the opposite side. 'Across' is defined as a relational preposition that depicts 'unbounded' motion from one side to the other side of a ground starting and ending near the 'boundary' of the narrated space (within it, on it, or beyond it). She concludes that participants seek to make contributions within shared space, as opposed to their own gesture spaces, or the gesture spaces of others (Özyürek, 2002, p.702). Furuyama notes that this 'suggests that the meaningfulness of this type of gesture cannot be attributed to the mind of a single individual' (Furuyama, 2002, p.356).

2.2.12.1 ***Practice: 'interactional topologies'***

How are topic spaces to be detailed in representations of interactions? Emmorey's illustrations of cognitively distorted room-layouts can be described as schematic topological drawings, comparable to the theoretical concept of 'virtual maquettes' (Fig. 2.45).

[3] Computer Science students were asked to describe a *Java* class hierarchy to each other: for a triad of interacting participants working with a non-spatially determined domain (rather than in a purely spatial descriptive task).

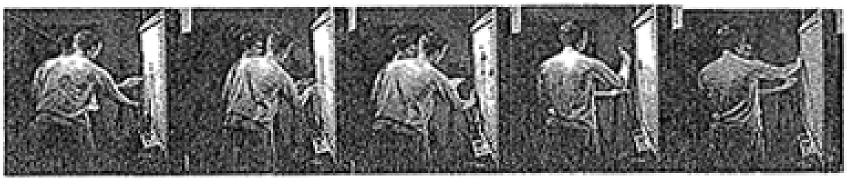
Beyond a detailed transcript, Healey does not represent the maquettes via drawing or another form of visual representation, while he acknowledges the phenomenological or qualitative significance of topic spaces by describing relationships between them as a topology of interaction. Özyürek makes little use of graphical representation to display her results. She does not amass results into a viewable format, as McNeill does with his gesture space schema diagrams. Nor does she give any specific examples of how spatial locations are managed, preferring to treat these as quantifiable relations. These relationships relate to the topology of the interactions but are not pictured as such. Her research interest lies in defining gestures as 'nonlinguistic signals,' asking to what extent do speakers take into consideration their addressee's thinking when gesturing. Interaction is characterised by Özyürek as a mental process, implying that it cannot by definition be pictured.

However, experimental procedures often produce visual outputs which are not published. Özyürek and her assistants trace directly from the screen displaying source video data, as Efron did from his screen-projected analogue film footage (Sect. 2.1.1.1, Fig. 2.18). She writes:

> In order to consistently and objectively classify gesture axes, coders traced the gesture's trajectory from the video onto a transparent sheet placed directly onto the monitor screen. Later coders classified these traces into one of the three axes. (p.693).

These axes are lateral, sagittal, and vertical, and are used to code each gesture phrase (her 'basic unit of analysis') using the sub-units of preparation, stroke, and retraction (McNeill, 1992).

Özyürek and Furuyama consider that speech and gesture are 'signs,' while Gill speaks of the workplace 'floor' being shared by collaborators, in a performative sense, whether or not they are working in relationship to the same established topic space (Gill, 2008). For Gill, a *Parallel Coordinated Move* (PCM) carried out by collaborators, is described as people working-in-unison despite the fact that they may be working in different parts of the physical setting, although perhaps in sight of one another. Gill's transcript employs a series of video frame-grabs, placed



1. E: Do you want us to do like a bed	E: CA:suggestion
2. (E moves in to the whiteboard, index finger point touches the	E: BM:Focus
3. surface; F is already drawing at the surface).	
4. E: and then that then	
5. (E's finger traces the outline of a bed)	E: PCM
6. (F is drawing at the surface, in a line to the left)	F: PCM
7. E: one here	E: CA:Suggest
8. (E moves his hand down and taps the surface, of the space	E: BM:Dem-Ref
10. that he has just traced, with the back of his hand);	
11. (F traces the outline of the bed in the air, moving his hand	F: BM:Ack
12. straight to the left and back and then down).	
13. E: and then | one here	E: CA:Suggest
14. (E lifts his hand up and taps the board again with the back	E: BM:Dem-Ref
15. of his hand; at |, F moves his hand back to original position	
16. Silence: (E lifts hand off and away from the surface, as F is	
17. about to touch it with is pen)	
18. F: ye	F: CA:Ack
19. (F puts pen back on paper; E's body begins moving back)	
20. E: and maybe do like a dresser between them	
21. (E's body moves back to rest-reflection position; F is drawing the beds)	

Figure 2.51: **Gill, 2008.** Parallel Coordinated Move (PCM) carried out by collaborators.

above highlighted (boxed) speech-turns (Fig. 2.51). She does not attempt to visually represent the specific dynamics or spaces that are created during the moments of coordination described in her text.

2.3 Summary of the survey

Immediately below a selection of themes are discussed that have emerged from the review of the literature. A number of key points are also presented, to be carried forward as insight into what is required for new representational approaches (Sect. 2.3.2).

2.3.1 The significance of drawing

Prevailing drawing methodologies in research communities represent human interaction in terms of the content embedded in sparsely represented gesture and speech. This is seen as independent of situated and emergent characteristics of these spaces. Observation through drawing is a process that corrects this tendency, mediating between the 'communicative realism' of Streeck, and the need to develop a representation that does not exclude gestural objects and topical spaces that are not addressed by a naive 'communicative realism'. Why are the drawings and visualisations of interaction so 'halting and timid,' as Streeck says, compared to the outputs of artists in response to the same representational problems (Streeck, 2009)? It is convincingly argued by Streeck that faltering and heavily segmented representations of interaction are the result of a prevailing positivistic outlook with regard to representing shared space. This presents interaction as staggered and discrete physical events with little to apparently connect them.

If drawings are limited in their fidelity to the material world, as Murphy claims, what is the alternative (Murphy, 2012)? When faced with data that requires the treatment of topic space for example, researchers have fallen back on diagrammatic hybrids of photography, labeling, and drawing (Sect. 2.2.8.1, and 2.2.10.1). Kendon for example, reproduces a photograph of a 1970's campus scene showing a group of three people in standing conversation (Fig. 2.1). The superimposed dotted lines delineate Kendon's interactionally differentiated zones, showing them as concentric circles at their feet. The innermost *o-space*, is followed by the *p-space* within which their feet are planted, and radiating dashed spoke-lines denote the undifferentiated outlying *r-space*. This part-photographic and part-drawn image is a schematic template for standing interactions of this kind. A direct correlation is not established between the template's geometric attributes, and the empirically observable topographies of interaction, including topic spaces, for example.

Historically, the representation of human movement through time and space has been an 'intractable' but alluring problem for artists and scientists alike (Streeck, 2009). Photography and the moving image poses the problem in a different way, but the issue remained how best to show the human frame and its limbs in continuous movements expressing thought and feeling. These motions can be exceptionally convoluted and sinuous in form. The Venetian ‘grappolo’ or hooking sign, with its repeated back-and-forth trajectory, is difficult to represent in its entirety, as one image, since it loops back over itself several times. Then there is the problem of how, when, and where, speech is built into this representation.

This question was first systematically addressed by David Efron in the 1940s. While making his comparisons between the frequency and type of gesture usage of first and second generation Italian and Jewish immigrants in New York, Efron employed an artist to draw the typical shapes of the vectors that their arms produced in the air. He also found that the films of their public interactions served as a basis for movement graphs. These were drawings from which quantitative observations could be made. His general approach to visualisation was adopted and adapted by later authors such as Klima and Bellugi, McNeill, and Kendon, remaining influential today.

2.3.2 Overview: areas for further exploration

For many of the authors mentioned in this survey interactional space can be read off from the bodily spaces and are entirely based upon them. However, their static images are not aimed at showing how space is utilised as a medium for communication. From this survey it can be concluded that if such writers were to take steps towards this goal they would need to do three things:

1. Look at the spaces between the members of the group.
2. Somehow frame these intermediary spaces as ones that are produced jointly.
3. Devise a method for representing phenomena such as topic spaces that do not have a concrete physical manifestation.

To be sure, qualitative space is found within the physical reach space, but interactions also have qualitative outcomes in spaces well beyond our arms reach, in areas that are are jointly created by people who are at a variable distances from one another. Reflecting on proximal and distal space initiated the concept of *f-formations* and *o-spaces* from Kendon, notions that seek to account for behaviour whose effects are felt at a distance from the body, even with a slightly expanded sense of what counts as a 'transactional segment' (Kendon, 2010). To date, there is an absence in the literature of empirical pictorial schemes designed to represent topical spaces in interaction, other than as we have seen, wholly schematic drawings and digitally inscribed video stills.

Theory has identified a diverse range of topic and gesture space phenomena to be studied, and analysis of these would benefit from drawing's flexibility and responsiveness. The phenomena have been named variously as 'Parallel Coordinated Moves' (as in Gill's case), 'between-person completion' (Furuyama), 'catchment' (McNeill), 'endowed gesture spaces' (Goodwin), 'imagined objects' (Murphy), or 'gestural maquettes' (Healey). The theoretical ground has thus been prepared for new approaches to the visualisation of interactional topologies that are not wholly dependent on body-centric criteria.

To summarise the above survey, there is room for improvement in drawn representation of interaction, particularly where phenomena demand a topographical richness and a non-abstract visual characterisation of shared space. A number of opportunities arise if the theoretical and representational emphasis is shifted away from the conventionally used 'markers' of individual bodies, in particular, heads, feet, and torsos. The identified issues cannot be resolved with the graphical techniques already in use, such as arrowing and dotted lines, for example. This set of problems requires new approaches.

Finally, the following specific themes and requirements for further work have emerged from the survey, focusing on space as a resource for communication. It is noticeable that many of these points are not exclusively defined by body-centric criteria:

1. The potential for participatory involvement of the observers of interaction.

2. The requirement drawings of artist Van Veen (Sect. 2.1.4.1).

3. The requirement to resolve tensions between frontally acquired data and the need to de-

scribe space more fully, and to do so in a way that is accessible to all readers, with all types of spatial abilities (Sect. 2.1.1.1).

4. The requirement to develop a visual topography of specific interactions (Sect. 2.2.7).
5. The requirement to draw a richer and more varied, and at times, interpretive picture of the space to which all members of a group have access, which is the *o-space* (Sect. 2.1.2).
6. The requirement to show the 'rapid plastic remapping' of near and far and other qualitative attributes, as they are felt in peri-personal space, and also beyond this in distal shared space (Sect. 2.1.5).
7. The requirement to provide a means of portraying interactional space as 'fields' or zones showing new peninsulas of shared attentional space, or regions of possibility and potentiality (Sect. 2.1.5.1).
8. The requirement to describe 'laminations' or layerings of semantic meanings within 'narrated spaces' (Sect. 2.2.1).
9. The requirement to track 'shifting indexicals' and other effects of spatial non-contiguity that are deliberately created during interaction (Sect. 2.2).
10. The requirement to represent gesture-completion, gestures that are initiated by one participant and continued (and possibly added to) by a collaborator. For instance, in the context of mathematical teaching, gesture space is used in teaching interactions (Sect. 2.2.8) and in origami lessons (Sect. 2.2.10).

Pictures help us to get a sense of how gestural movements point to their own place in space, or *Deixis 2* (Sect. 2.1.2). The reflexive and layered nature of gesture requires a similarly layered and structured approach to its representation. This is where the suitability of drawing is very apparent, since drawings can encode nuanced interpretations of space directly into analytic representations of data.

Chapter 3

Case study: Non-metrical space in communication

Surveying the literature has identified a number of places where drawings can either be improved or where there is evidence of a gap in existing visualisations. The Case Study will present data that requires exploratory investigation through drawings that will address these gaps in the literature.

These lacunae relate to the various ways in which human behaviour plays with the content of discourse by displacing, shifting, extending, and flipping spaces that are created during interaction (to be referred to as 'non-metric' spaces).

Much of what follows in this chapter is designed to illustrate why Turn 20 is pivotal within the interaction, and is ultimately aimed at showing why the visual representation of these non-metric phenomena is such an important issue. Architects manipulate such spaces as part of their professional shared activities, casually but precisely establishing and then altering them in collaborative discussions.

Language and text present the bare facts of who is acting, when, and where, but cannot *show* us the relationships and the topologies that exist in and around these actions. This thesis argues that the role of drawing is to bring these topologies into view and to assess how they can be approached analytically. Without a visual means of doing so, we will be confined to textual descriptions that can never access the full variety of relationships. Drawings of Turn 20 should throw light on these non-metric events, but also on those that surround and support it throughout the discourse.

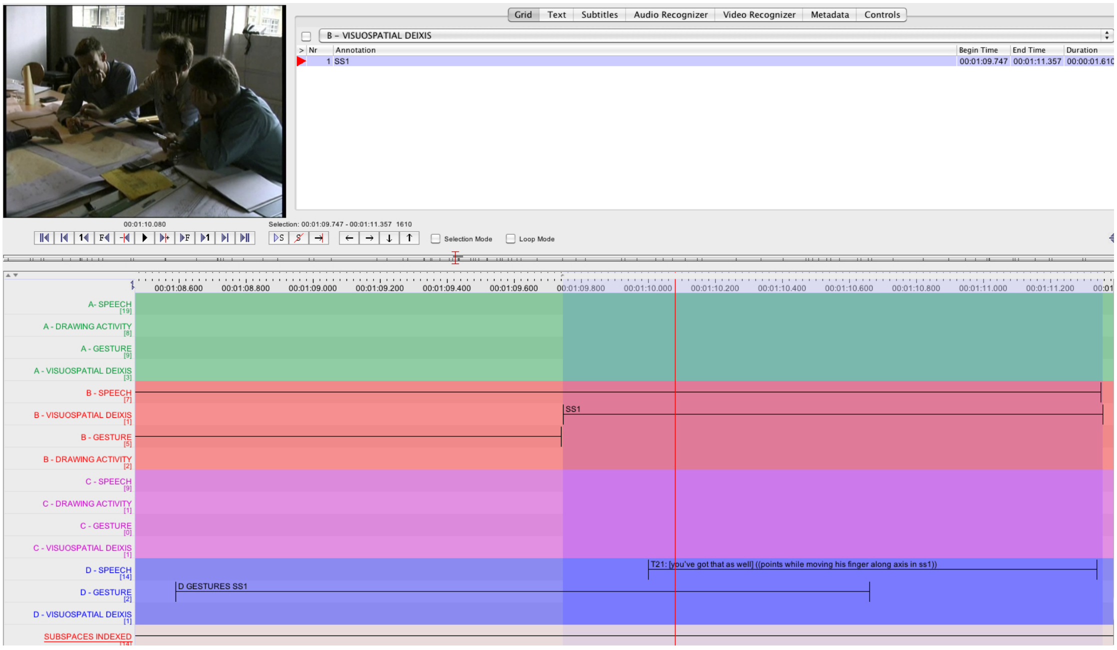


Figure 3.1: Case-study data: speech turn 20, **B**: ‘the opening is actually here.’

A previous ethnographic study collected data on collaborative design interactions at an architectural practice. The architects use their bodies, pens, gestures, pieces of paper, and inscriptions of different kinds, to create a series of temporary gestural ‘maquettes’, or models of proposed design changes (Healey and Peters, 2007). New instances of these phenomena were found in the corpus.

Gestural models are embedded within patterns of visuo-spatial deixis (Sect. 2.2.2). The maquettes serve, in part, to depict the structure of different design alternatives. Gestures are therefore temporarily able to describe the spatial relationships of domain topologies within a conversation. However, the patterns of production and placement of these maquettes can only be fully understood if we consider how participants also adjust their relationship to other contributions. For example, whether they contrast with, elaborate, or integrate other design proposals. In each case, the spatial organisation of people's contributions is actively managed in ways that help to make these relationships physically manifest. The background, transcript, and preliminary analysis given below, aim to elucidate upon this use of non-metric space in the architect's meetings.

3.1 Background to the Ethnographic Data

Video and audio data was gathered by Charlotte R. Peters and Professor Patrick G.T. Healey during 2007, at Edward Cullinan Architects (ECA), in London. Approximately 6 hours of video material and simultaneous audio tapes, gathered in the workplace.

While working on a competition bid, the architects discuss design possibilities, at a group meeting where printed plans and elevations are overlaid with hand-made drawings (onto semi-transparent yellow 'detail' paper torn from a roll when needed). Interactions illustrate shared space phenomena, and Clip 1 in particular is studied in detail. This clip will be used to test a selection of representational methodologies borrowed from the literature (Chap. 4). The clip will also be used as a basis for drawing experimentations (Chap. 5).

This excerpt of 2:53 minutes duration displays a spectrum of drawing-type gestures scaled relative to the visible plans and drawings. These 'icono-indexical' gestures align with paper spaces, and are grounded upon them, maintaining relative positions of the designs. Vector-based digital drawings (CAD-assisted) and rasterised Photoshop documents are also viewed on monitors during a number of these discussions.

Collectively these have been termed 'drawing spaces', or 'sub-spaces', and been numbered according to the order in which are referenced. They relate to inscriptions made on paper and in gesture. The sequences of turn-taking in the conversation illustrate the close relationship between these physical drawing-spaces and topic spaces (Appendix. A.0.2.11).

A small number of multiparty and dyadic clips were annotated using the ELAN tool (Sect.

3.2.1, Fig. 3.1). This is the *'Eudico Linguistic Annotator'* and has been developed at the Max Plank Institute for Psycholinguistics in Nijmegen.[1] This excerpt was chosen as an excerpt that offered significant opportunities for further work, and screen-shots of the excerpt are included. For example, they show the distribution of seated people around the oval meeting room table (Figs. 3.1, and 3.1).

Figure 3.2: Screenshot of case-study video data, showing the large oval meeting table. Taken from Clip 10.

[1]For further information see: http://www.lat-mpi.eu/tools/elan/

Figure 3.3: Screenshot of case-study video data, a different view. The large oval meeting table. Note that **D** has his left arm in a sling. Taken from Clip 10.

3.2 The transcription of the data excerpt

Description: Multi-party, seated. Tabled meeting with architects **A**, **B**, **C**, and **D**.

Date: 6 July 2000.

Source: Video 6-7-00.

Keywords: Architect **B**, ‘the opening is actually **here**’.

The below transcript is based upon McNeill’s conventions. This is a generic form of conversation analysis (CA) using turn-taking (Sacks et al., 1974). The transcript is not augmented by visual material, which in multiparty interaction is acknowledged to add insight (Ten Have, 2007). The transcript is intended to represent turn-taking patterns, ‘repairs’ of meaning, and ‘self-repairs’, plus the co-speech situated gestural productions. Video frame-numbers are not used (although later drawings sometimes refer to these for sequencing purposes).

/ pauses under 0.5 secs

// pauses over 0.5 secs

///// indicates longer pauses

(( )) actions

Gesture and drawing actions described in = *italics*.

square brackets = overlapping speech

ss denotes numbered sub-spaces

3.2.0.1 ***Transcript***

1. A: ((*points with pen ss1, 3*)) that door/ all the way through there

2. A: ((*continues drawing, ss1*)) you can drop the door / so that you've got // that zone there / is all open and free // ((looks at D))

3. B: oh yeah

4. A: yeah? //

5. A: so th-thats just all air // ((*points ss1*))

6. D: uhum /

7. C: yeah

8. A: ((*drawing with red pen in ss1*)) and then somehow / you've got a // I was having the door be up to that level / but / at the moment we got //

9. A: the canopy is in that ((*points ss1*))zone // yeah?

10. D: mm

11. A: / you can drop the door (0.5) you have got that zone there / but its going to have to be louvered //((*draws horizontal lines to show louvers, ss1*)) [above the]-

12. C: [w]-what does the elevation of that door look like / if you were looking at the door? ((*hovers and points repeatedly with pen at ss3*))

13. A: Umm / this is the first time its been drawn // as we speak ((*drawing with red pen, ss1*))

14. A: ((*points and continues to draw is ss1*)) so that thats that will louver / that that thats the crinkle-crankle/ zinc / and thats the door ((*points*)) /

15. A: well/ but its actually going behind there b-b th-the door's there ((*draws rectangle in ss1*)) / say like that ((*continues drawing in ss1*)) // handle ((*draws handle*))

16. A: s-so i'm i'm drawing that bit of louver there ((*draws, ss1*))/ for/ your benefit (0.3)

17. A: so but you're always its always gonna be a louver isnt it? /

18. B: ((*points with pen, ss1, 3*)) thats not great because

19. C: [Hmm]

20. B: [thats] / the / ((*moves away from ss1 towards ss3 but back again before reaching it*)) opening over the door [is actually here] ((*raise pen off sheet and draws a roughly rectangular shape above it*))//

21. D: [you've got that as well] ((*points while moving his finger along axis,* ***ss1x***))

22. A: you've got that above it, yeah / ((*points and draws, ss1*))

23. D: for that whole width? / ((*indicates, ss1,2*))

24. A: yes

25. D: so you got that/ ((*points, ss1*)) plus that ((*points, ss2*)) Bill / (to bring over the free air)/

26. D: [Its not enough]

27. B: [w-whats wrong] with the what Kevins proposing to actually if you pulled out that whole of that / w/hole / theres / the whole of that portion you're actually letting in // and we / we re-engineer this corner / ((*while drawing in ss3. A tears off sheet and commences to draw in new ss4*))

28. B: I mean c - if we went back down to commons ////

29. D: mm mm

30. B: well in this corner/ it started as a f-five hundred by five hundred diameter column / so if it was a bit smaller? / ((*points to SS3*))

31. A: uhum /////

32. C: ((*points with pen towards ss1 drawing by A*)) how high is this again? /

33. C: from the ground to //

34. C: ((*points with pen at point* ***ss3x***)) f-f-from standing in/ standing at that point there //

35. D: yeah/

36. C: to//soffit/

37. D: two one nine seven /

38. D: two nine one seven / plus four fifty

39. C: two nine one seven? /

40. D: yeh (15.0) ((*A continues with s4 drawing in front of him, while the others watch*))

41. C: hmm ////

42. D: almost///////

43. C: I think that looks great /

44. A: (laughs) /

45. A: w-w-which bit / tha-tha this whole thing as a kind of air scoop? ((*rapidly indicates with circling motion the area above ss1, with hand and pen in a similar area to that of B gesture at Turn 20*)) /

46. C: yeah / mean what I was thinking was / if its two nine one seven right? /

47. A: uhum

48. C: plus four fifty / whas the four fifty?

49. D: thats the depth of the beam ((*while looking at drawing in ss1 and underneath*))

50. C: oh ok / plus four fifty /// its about three point three yeah? ((*writes in between ss1 and ss3*)) // then my silencer / is nine hundred and sixty high ((*pointing at ss4*))

3.2.1 ELAN annotations

Below is the coding structure for the four architects featured in excerpt.

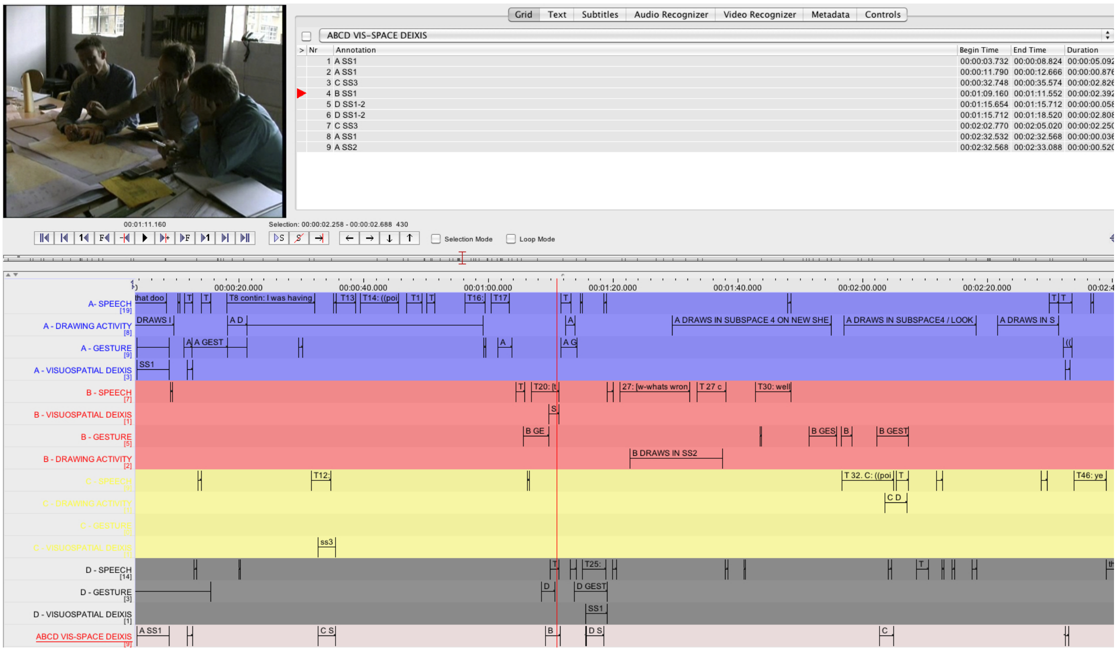


Figure 3.4: Catchment, the distribution of the linked visuo-spatial speech-turns, as seen in ELAN. Turn 20, **B** (Red): 'the opening above the door is actually here.' This screen-shot shows the entire length of the clip, the red hair-line at Turn 20. The lowest tier contains the annotations of catchment.

A = Blue. **B** = Red. **C** = Yellow. **D** = Black.

3.2.1.1 ***ELAN Tiers***

Speech Utterances are given, with speech Turns from the transcript. Descriptions of actions are also sometimes given in this channel, linking the speech to the relevant tier for gesture and drawing, and as an aid to the reading of the results. Speech-turns have been taken to be utterances that form sentence-like units that stand out as independent contributions to the annotator (Schegloff and Sacks (1973), Sacks et al. (1974)). The process of identifying Turns is based upon whether an intuitive reading can be made of the interaction from them, and there is no stricture applied as to how short or long a Turn might be. They can be broken into smaller sub-parts that are not Turns in their own right, and can contain short pauses.

Anchoring Points (APs) Defined points of agreement in the conversation. Anchoring points include minor backchannel confirmations that commonly occur in dialogue to show continuing attention, as well as substantive agreement (Clark (1996)). For example, Turn 10, D: 'mm'; and Turn 6, D: 'uhum.' Annotations have not been separated into the communicative 'Tracks' posited by Clark: a primary one for speech, in which 'official business' takes place, and another for meta-communicative acts such as gesture (Clark also says gestures can reside in Track 1). Anchor points have not been included in the transcript below, but are made reference to in other representations of the extract.

Drawing Relates to the physical drawing movements. Not restricted to those moments where a pen or pencil is actually touching the sheet, and preparatory hand moves around the sheet while drawing.

Gesture Gesture and Drawing tiers are closely related, and sometimes inseparable, given that the architects work very often while holding pens and their arms poised over the drawing spaces. The aim is to distinguish the predominantly drawing phases from the predominantly interactive gesture phases (Bavelas et al. (1992)). Further descriptions given within the tiers facilitate this distinction.

Pointing and drawing: Visuo-spatial deixis (VSDs) These gestures are distinguished from all other gestural productions by being placed in their own tier. Their spatially indexed character simultaneously underpins the topics of discussion, explicitly introducing an analytic interpretation into the data presentation.

3.2.1.2 ***Sub-spaces***

Sub-spaces, for the purposes of this transcript, are described as the units of space that stand out from the background context, and from other sub-spaces, due to events within and around them. New spaces are dependent on whether those present behave towards them as new.

These are inextricably bound up with contributions to and management of the topics within the conversation. The business at hand determines whether a current or new sub-space has been created and later referred to. Newly created sub-spaces are important to topic management in interaction: 'ways in which actions accomplished in conversation require reference to the properties and organisation of conversation' (Schegloff and Sacks, 1973, p.290).

A key criterion is that a sub-space resides in an area that is mutually accessible to those present. Speech is a key criterion for tracking participant's involvement in sub-spaces, as well as posture and head orientation. Occlusion of faces necessitates that a combination of speech and posture will be used o determine whether a particular sub-space has been referred to. Renegotiation of sub-spaces is determined by speech that can be considered as a redefinition of the question under discussion (Ginzburg, 1996). Speech and gesture that return to an existing topic and its associated physical sub-space, can be considered a re-establishment of the original question under discussion (**B**'s Turn 27 as a remodelling of the question, for instance).

3.3 The architect's production of sub-spaces

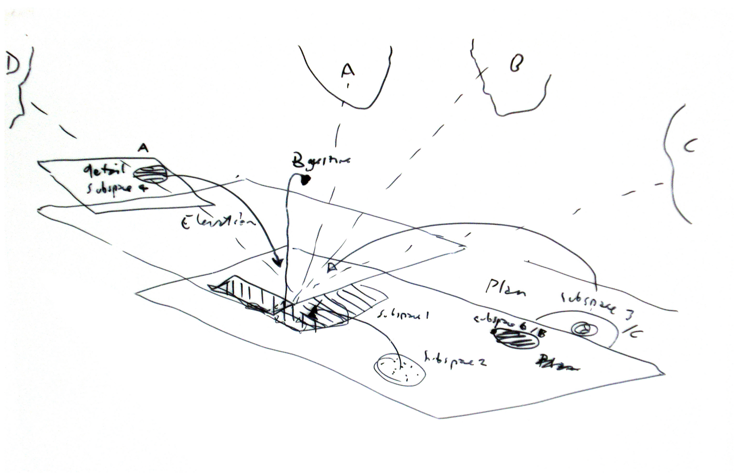


Figure 3.5: A first sketch attempting to organise the relationships between sub-spaces 1-4.

Overview. **A**, furthest from the camera, leads the meeting. His actions demonstrate that he has the authority to control the debate and the way in which the table space is used. Interspersed throughout the discussion there are prolonged periods of silent observation in the group (up to

30 seconds). These long pauses are eventually followed by a shift in attention towards a new drawing in sub-space 4, towards the end of the extract, that will help to break the impasse in the design work (Turns 40, 43, 50).

Sub-space 1 is re-developed. Architect **B** indicates the proposed 'opening' on the plans in sub-space 1 (Turn 20). He then draws the rectangular shape of the opening using the tip of his pen in the empty space immediately above the table, apparently grounding his gesture in the jointly managed sub-spaces. The dimensions of the gesture appear to be consistent with the internal drawn dimensions of the plans.

B and **D** appear to be in agreement about there being not enough room to accommodate a proposed feature of the design (Turns 18, 26). The printed elevation or 'section' in sub-space 1 shows a doorway underneath a canopy and *louver* (slatted window).

The space under discussion lies between the forward-projecting canopy and the top of the door underneath it. The question posed is whether the 'silencer' (Turn 50) can be accommodated here. **A** suggests that 'its possible to drop the door', as if doing this might be of some help, but immediately qualifies this suggestion (Turn 11).

A's pen drawing in sub-space 1 augments the black-and-white printed elevation or 'section' underneath it. **A** is provisionally drawing an additional detail to the proposed design at the outermost edge of the printed designs.

Sub-space 3 emerges. A further sub-space 3 is identified by frequent references to it from two of the architects sitting closest to it, **C** and **B** (Turns 12, 20 and 34). The character of sub-space 3 is internally related to that of sub-space 1, and cannot be entirely separated from it, despite the mode of projection being different in either case. Speech-turns that are linked to sub-spaces 1-3 have been tracked in a graph (Fig. 3.6).

From **C**'s utterance at Turn 12 ('what does the elevation of that door look like/ if you were looking at the door?') we can infer that sub-space 3 is in a different projection to that of sub-space 1.

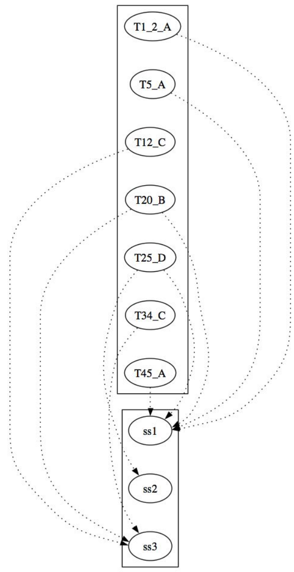


Figure 3.6: Directed graph of the visuo-spatial cohesive thread. Agreement or anchoring points occur at Turn 3 (B), 22, 24 (A), 35 (D), and 47 (A).

3.3.0.3 ***Joint gestures***

B's tracing out of the 'opening' in the air, points to the same state of affairs that **D** intends to pinpoint on the flat plans with his small fingertip movement (Turn 21). Each chooses to represent the same information in different ways. **B** has added a further dimension to sub-space 1. The transcript does not fully represent the interwoven contributions at this point.

D points at this spot (shown in the transcript as a sub-space: 'ss1x') and moves the tip of his finger back-and-forth a few centimetres. If he wishes to identify this spot and confines himself to the projection of this drawing, he can only make a small gesture along this axis.

3.3.0.4 ***Pivotal Turn 20***

B's aerial gesture at a single stroke reiterates, delineates, and locates, the 'opening' (Turn 20). It is a layered contribution, combining deixis with iconicity in such a way to move the discussion forward. Such phenomena have been described in the literature by Haviland as 'laminated' with 'complementary dimensions of projected spaces' (Sect. 2.2.1).

D could have drawn in the air to make this point, and why he did not do so can only be surmised. It is possible that there was reluctance to markedly deviate from professional conventions, or that his right arm being in a sling may have restricted his movements. The inward rush of **A**'s arms, in readiness for his next contribution, brings the focus of attention back down to the table surface.

3.3.0.5 ***Sub-space 4 is founded***

A tears off a new sheet (Turn 27) and his verbal contribution shows that he is simultaneously following the line of argument being developed over sub-space 1 (Turn 31). **A**'s new drawing is to one side of sub-space 1, and is intended to be a contribution towards the same development of ideas, as the subsequent conversation confirms.

There is a moment of recognition (Turn 43) for **C** when he sees how the proposal will work:

> **C**: I think that looks great!

This refers to **A**'s unfinished perspectival drawing in sub-space 4 (he looks towards it, but we cannot see where his gaze travels due to his face being averted from the camera). It is an exclamation of **C**'s understanding the problem and the most recent proposal. All of his subsequent contributions in the clip are aimed at explaining how he sees that this will work as a solution.

3.4 The challenge: drawing patterned interactional space

The previous section presented data that requires specific representational solutions, in order to show the temporal and spatial relationship between the contributions of the architects.

McNeill's discussion of Catchments, posits a 'thread of visuospatial imagery' that runs through the discourse. The patterning effects of these co-speech gestures exercise a cohesive effect upon the discourse, maintaining or changing its topical direction. This unifying effect can be seen in the sequence below, containing utterances and gestures that can be 'thematically related but temporally separated' (Sect. 3.4.0.6).

Catchment builds a spatio-temporal picture of how shared understanding is incrementally achieved in interaction. This involves partially or fully recurring features of shape, movement, space, orientation, and dynamics (McNeill et al., 2001). For the purposes of the present work catchment includes all parties rather than one individual.

This approach allows us to frame the group's management of the topics, without losing sight of the character of individual contributions, such as 'the recurrent use of the same trajectory and space with variations of hand shapes', and where 'meanings are grouped but with contrasts among them' (McNeill, 2008, p.3).

There can be no doubt that this chain of gestures are a highly effective vehicle for potentially crucial and very rapid communication. However, in the written transcript these gestural movements are generally reduced in the literature to short-hand forms such as: 'indicates' and 'points', or 'gestures above.' These descriptions do not evoke the dimensionality and interrelatedness of the contributions (Sect. 3.2.0.1). The same can be said of an identical transcript that has had video frame-grabs added to it (Appendix. B). The inclusion of a necessarily limited number of thumbnail images do not remedy the above issues, but other representational strategies may.

3.4.0.6 ***The cohesive thread: 'a kind of air scoop'***

The chain of catchment is described below, so that further work may be focussed on one task, with many levels of complexity. This does not indicate a theoretical investment in the concept of catchment, which is used here in order to sift out representational challenges to be dealt with in following work.

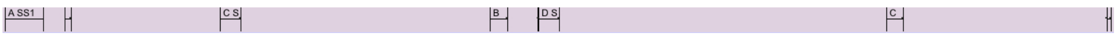


Figure 3.7: The chain of visuo-spatial deixis, a tier from ELAN. Seven contributions distributed over the extract of 2:53 minutes duration.

Turn 2.

At the beginning of the clip **A** sketches his provisional design concept on the paper surface of sub-space 1. While making a skipped motion that is a mix of gesture and active drawing with the pen-tip on the surface of the paper he says:

> A: ((*continues drawing, ss1*))
> that zone there / is all open and free //

Turn 5.

Following this **A** reiterates that he refers to an empty space that is relevant to the problem-solving discussion. He sweeps his pen around the area above his drawing, saying:

> A: so th-thats just all air //
> ((*points ss1*))

Turn 12.

The uprightness of a pen brings the imagination of the architects to bear on a particular viewpoint, that of a notional observer standing at a spot. The repeated up-and-down movement emphasises his point and animates the notion of moving to and being in that place. **C**'s pen stands on its tip in the middle of sub-space 3, as he asks the group:

> C: [w]-what does the elevation of that door look like / if you were looking at the door?
> ((*hovers and points repeatedly with pen at ss3*))

Turn 20.

The airborne gesture by **B**, is a response to the spatial prompting of the preceding question at Turn 12, and the 'open and free' air space gesturally identified by **A** (Turn 5). This gesture traces out the rectangular shape of the opening above the door, at an angle that is roughly orthogonal to the Section and tabletop. In other words, it is more or less vertical in orientation. Of all the gestures in this extract it makes the greatest use of the space above the table:

B: [thats] / the /

((*moves away from ss1 towards ss3 but back again before reaching it*))

opening over the door [is actually here]

((*raises pen off sheet and draws a shape above it*))

Turn 25.

Here the gestural bridging is extensive and descriptive of the metrics of the spaces in the design. Several movements are made across the two spaces and include movements that are meant to represent the bringing together of these metrics to deal with the ‘free air’ theme developed at Turns 2 and 5. Addressing **C**’s concerns (whom he calls‘Bill’), **D** says:

D: so you got that/

((*points, ss1*))

plus that

((*points, ss2*))

Bill/ (to bring cover the free air)/

Turn 34.

C recapitulates the perspective invoked by **C** (Turn 12):

C: f-f-from standing in/ standing at that point there ((*points with pen at point* ***ss3x***))

Turn 45.

While making his verbal contribution **A** makes a free circling gesture above sub-space 1, calling to mind **B**’s gesture occurring approximately 80 seconds beforehand (Turn 20), and his own before that (Turn 12). This circling gesture is a double loop which is directed downwards onto sub-space 1, in a similar place to that of **B**’s but at a lower altitude. This gesture in contrast to that occurring at turn 20, is approximately horizontal and parallel with the tabletop. The rising vector of **B**’s earlier gesture could pass through the middle of the later one, as a thread might pass through a loop:

A: w-w-which bit / tha-tha this whole thing as a kind of air scoop?
((*rapidly indicates with circling motion the area above ss1, with hand and pen in a similar area to that of B gesture at Turn 20*)) /

3.4.0.7 ***Conclusion: the multi-dimensionality of interactional 'catchment'***

Logical connections obtain between sub-spaces 1, 2, and 3, substantiated especially by speech (Turns 12, 20, 23, and 25). This is despite the fact that the architect's plans and sections are orthogonal to one another. The gestural contributions maintain the logical connections but also manage this non-contiguity.

One theme emerging from the literature review is that chains of cohesives can demonstrate vertical patterning amongst predominantly horizontal workspaces. This is said to contstitute a noticeably 'poetic' dimension that also performatively unifies the discourse (Sect. 2.2.9, Furuyama (2000)). They provide a marked contrast within the setting of the meeting where eyes are very often downcast and gestures hover over drawings that are laid out flat upon the table. The poetic dimension of catchment has been described as adding an imagistic or non-linear component to the unfolding 'packages' of logical thought (McNeill and Pedelty, 1995).

Speech-turns identified in the previous section (Sect. 3.4.0.6) show that spatiality is invoked in individual ways but that these are a part of the shared competence of the group. **A** sets up the space immediately above the table as a topic area for the debate, and **B** develops upon this with his spatially located shaped gesture with his pen. **B** specifies the problem zone (the one which compromises the 'open and free' area demarcated by **A**), by drawing it out briefly in the air. **A** at Turn 45 returns to this theme by a recapitulation and renaming of the theme of the 'open and free zone' as 'a kind of air scoop' (and his gesture moves a little higher above the sheet this time).

ELAN restricts itself to combining linear textual annotations with a time-line of video. It is exactly this type of spatially interwoven and imagistic quality that most two-dimensional drawings and textual descriptions of interactions struggle to accommodate. A transcript of the excerpt with selected video frames is annexed illustrating this difficulty (Appendix. B). What is required are representations to take account of the multi-dimensional and incremental structure of qualitatively organised movement and speech.

The architects flip between different projections in different sub-spaces, in order to maintain their shared conceptualisation of the three-dimensional design. Transitions are rapidly and jointly made between different paper and gestural projections of the same problem-space. The necessity to accommodate these transformations results in spontaneous gestural and spoken responses that are best described as non-metric, and require perspicuous representations. The question for the following chapter is how this tendency of the architects (to use a natural mapping between real space and designed space) can be reconstructed in two-dimensions.

Figure 3.8: The chain of visuo-spatial deixis, segments from ELAN superimposed and colour coded. **A** = Blue, **B** = Red, **C** = Yellow, **D** = Black.

Chapter 4

Conventional reconstructions of the data excerpt

A series of new drawings are shown in this chapter, each of which have been constructed to depict the data excerpt (Clip 1). These drawings highlight the contrasts between each drawing technique and the impact this has upon the way in which shared spaces are represented. Wherever possible reference will be made to the requirements for articulating qualitative spaces with drawing techniques, identified in the survey of the literature (Sect. 2.3.2).

Image-based comparison is a powerful technique, best illustrated with an example. Ten drawings of the Dighton Writing Rock, in Massachusetts, made between 1680 and 1893, show how line drawings have been used to record ‘objective’ views of artefacts in different periods of history (Tufte and Graves-Morris, 1983a, Fig. 4). Although all of the drawings depict the same rock face, they convey very different impressions of it. This chapter takes a similar approach to the representation of the human interactions in this data extract. However, the subject matter is not a static object such as a rock, but data that has most probably never been visualised more than once, if at all. This makes it impossible to compare like-for-like, as Tufte does. However, to get around this issue, and permitting ourselves a certain licence, the same extract of data can be submitted to a series of contrasting conventions for representing gesture.

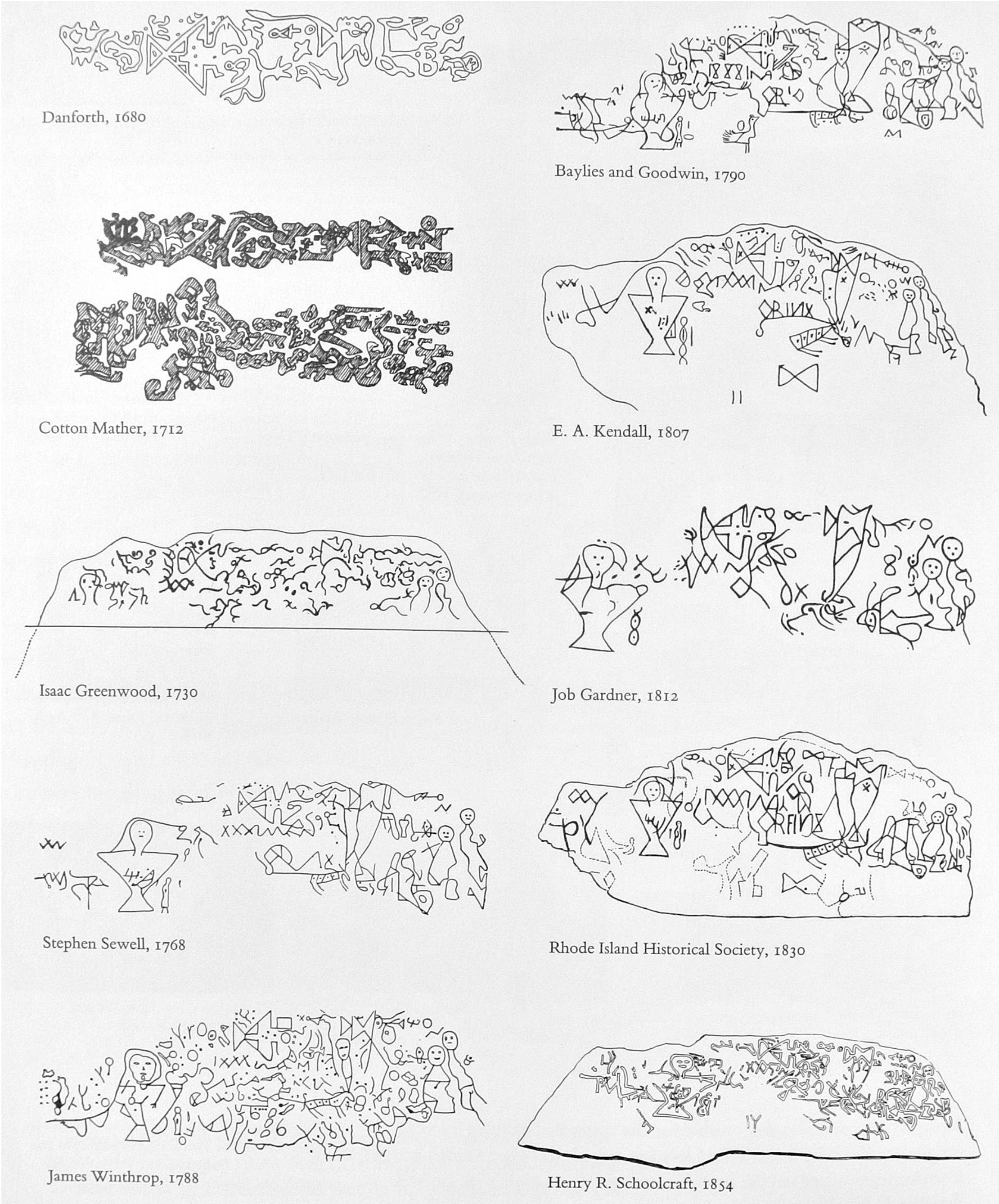


Figure 4.1: **Tufte, 1983.** 'Dighton Writing Rock in southeastern Massachusetts'. Drawings made between 1680 and 1893. From *Envisioning Information*, 1983.

A limited number of pastiches based upon the literature will help us to understand the manual and also the theoretical routes by which the original drawings were created. The decisions that were involved in their making, are best understood by retracing the steps that were involved in their creation. This will also highlight historical antecedents that have informed them.

Differing drawing conventions draw attention to the numerous and creative ways in which the methodological problems associated with data have been addressed (difficulties caused by camera position, occlusion, transience, simultaneity, for example). Utilising an array of drawing techniques, researchers have worked around such obstructions to achieve their outputs (Appendix. D).

Each representational approach has been tailored to meet the demands of the specific target concepts and specialist audiences. Efron, McNeill, Murphy, and Gill, are likely to have made specific decisions about graphic conventions, and mixes of these, in order to present the outcomes of their research. What must be identified is whether in some cases researchers have been unnecessarily restricted in the message they are able to deliver because of their chosen idiom.

These reconstructions cover the full range of representations, starting with the relatively sparsely depicted kinetics of interaction (Efron, for example). There are also drawings that are inter-linked with speech-gesture transcripts, and attempts to represent interactional complexity over longer segments of time.

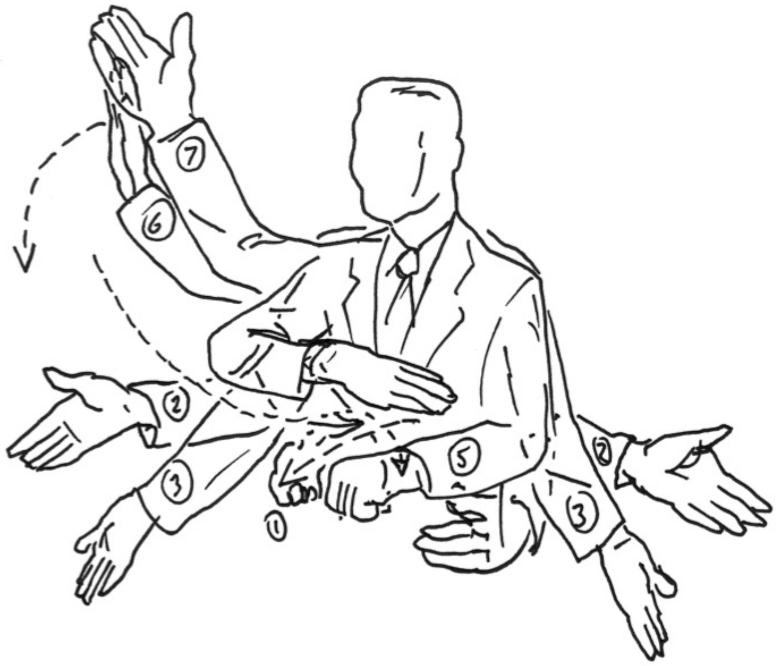


Figure 4.2: **A re-working of Efron, ink on paper, 2013.** This is an example of how reconstruction according to slightly altered conventions reveals why the original method was chosen. The original image showed stages of gestural movement displaced across the page, making it easier to read than this reconstruction (Fig.2.16). (Note that here stage 4 of the original has been omitted due to increasing complexity of the image).

4.0.1 Reconstructions: Following Efron

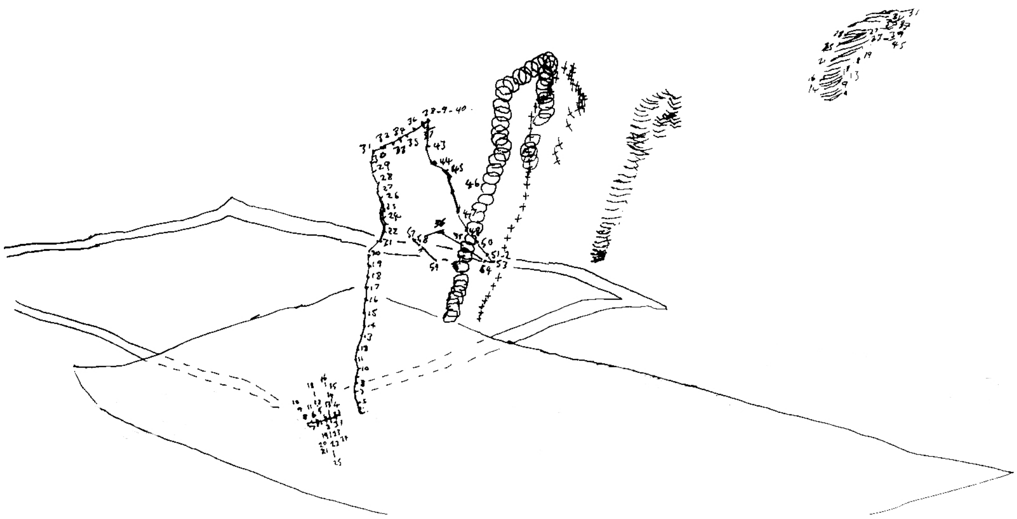


Figure 4.3: Architect **B**: ‘the opening is actually here’, Turn 20, and **D**’s overlapping Turn 21, ‘you‘ve got that as well’, on the paper surface at lower left.

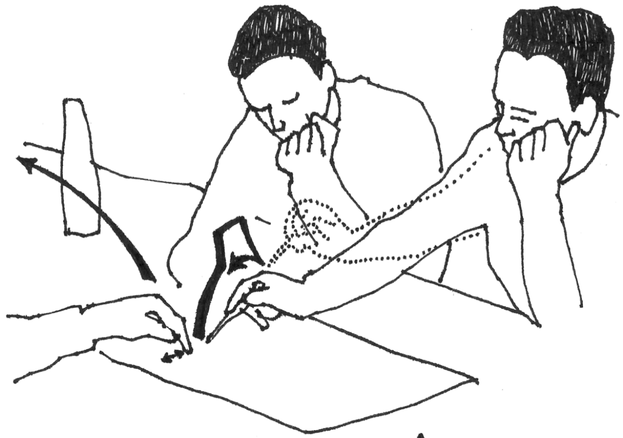
Kinetic mapping. 59 video frames constituting Turn 20 yielded the drawing that simulates Efron’s approach (Fig. 4.3), tracking gestural movement by limb parts: numbers and solid line relates to the tip of **B**’s pen as it moves. Overlapping circles relate to the tip of the finger that holds the pen. The line of small crosses track the end of his thumb, while the short horizontal dashes record the changing position of his wrist and elbow. Efron and his artist collaborator Van Veen aimed to code the relationship between wrist and elbow movement, the degrees of which were to be used as an indicator of cultural predispositions towards smaller or larger uses of gesture space. The use of drawing in this case was focused on tracking the body-centric kinetics rather than following the production of shared spaces (Sect. 2.1.4.1, Fig. 2.18)

This technique is good for following physical features precisely. The distribution of marks across the page allows inferences to be made about the relative speed of parts of the gestural movement, as it increases speed towards its end before retraction. The vector appears to reconnect with its own initial upward path originating from the paper surface. It does not meet up to form a closed rectangle, but the technique does not recognise that this is the most probable intention of the speaker. This method reveals how little the elbow moves by comparison with the hand, as we might expect since his arm moves at almost the fullest extent of its reach space.

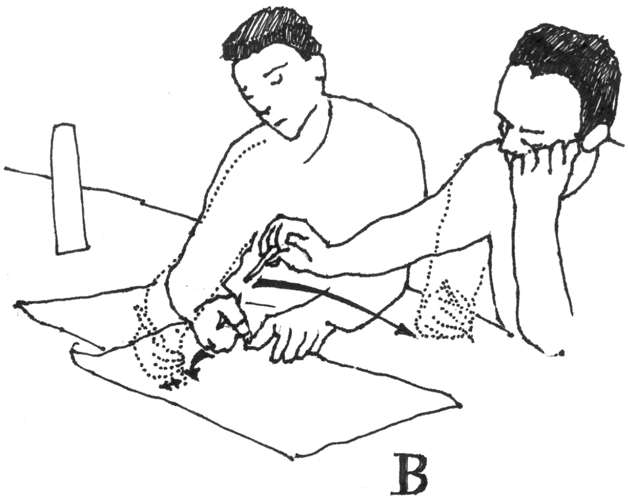
Typically the ‘kinesographs’ of Efron did not show any of the surrounding context, and many of his images depict solo figures, despite the fact that they originated from multiparty interactions.

Efron’s images of gesture were often but not always associated with explanatory text, and this sometimes included a non-technical presentation of speech below the image (Fig. 2.18). Occasionally the kinesograph was replaced or supplemented by an additional redrawing of the gestural pathway in the form of a ribboned arrow. This was in order to make the pathway clearer and to reveal how it folds back on itself. The redrawing of the clip following Kendon shows this as an appended vector. **D**’s forefinger moves along a small line on one of the Sections (seen on the far left). The smallness of **D**’s gesture belies its significance in the interaction, but would not lend itself to easy representation using this ribboning device (or any other for that matter). This is another example of how difficult is is to represent the production of shared space while using sparse techniques.

4.0.2 Reconstructions: following Kendon



A



B

Image **A**.

Architect B:
thats / the / opening of the door is actually HERE

|~~~~~~********************|

P S1 S2

|——————————fgp1——————————-|

Architect D:
youve got THAT as well
|~~~~~~~~~~~~~~~~*************|.-.|

P S1 R

|————-fgp2————-|

Image **B**.

Architect B:
|-.|

R

Architect A:
you've got THAT above it, yeah /

|~~~~~~~~~~~~~~~~~~~~~~~~~*****************|

P S1

|——————fgp3——————|

KEY: Utterances from each architect appear on separate lines.
fgp = Gesture phrases, numbered.
S = Strokes, numbered.
R = Retraction.
Symbols: / = Short pause. *** = Gesture Stoke. ~ = Preparation. -.-.-. = Retraction.

Tapering spaces. The tracking of indexical gesture is dependent on supporting text. No details of the drawings lying on the table are provided. The result is that a general picture is conveyed, where the spirit rather than the letter of the interaction is depicted. Kendon hand draws his representations for publication, developing a style that operates within the frameworks and conventions of his research community. Kendon's stated intention is for his drawings to draw attention to the important aspects of the data, supporting his own interpretation of it (Kendon, 2004, and see Sect. 2.2.2.1).

Despite certain feature changes in successive panels Kendon's figures convey substantial information, and stylistic anomalies only serve to draw the reader's attention to the unvarying qualities of the gestures. Neighbouring frames are generally used by Kendon to show movement increments. His drawings of multiparty interactions employ simple outlined drawings for the figures (Fig. 2.34). The reconstruction according to his conventions suggests that multiparty scenarios could be represented using adjacent panels showing increments in detail, if possible and if required.

Kendon draws arrows for some gesture retractions. Reserving the use of arrows for the main gesture phase will prevent any blurring between significant and insignificant movement. In this reconstruction the approach was that retractions are equally important to the interaction.

Even tapering arrows have limitations as to their ability to convey qualitative space. The type of arrows used to show the gesture paths of **D** and **B** are essentially the same, even though the two movements produce quite different spaces, and also have a combined effect upon eachother.

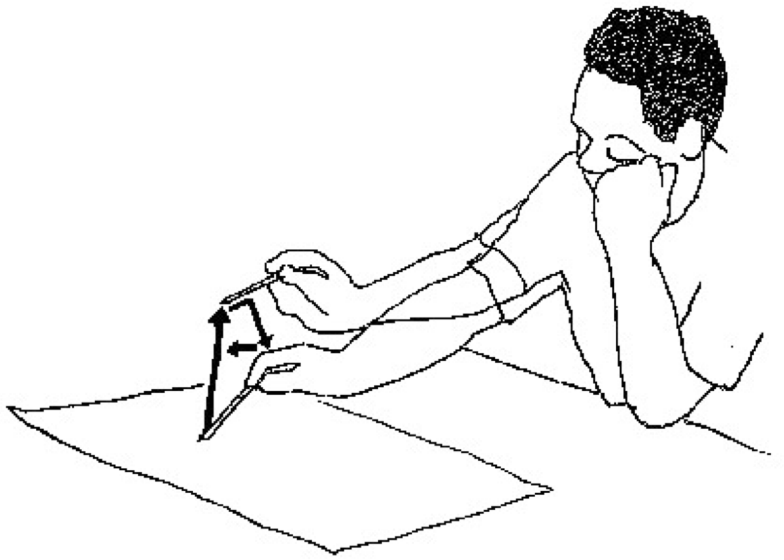
Following Kendon's example, later parts of movements are shown in dotted outline. On occasion he reverses this order and has the earlier portion in dotted outlines. In the reconstruction, the left hand of **A** has been omitted for the sake of clarity, since it is immediately behind the arrowed gesture path of **B**. Kendon rarely omits parts of figures, for reasons of visual economy or ease of reading. Instead he prefers to draw all of the visible figures, even if occlusion and proximity produce the occasional situation where lines awkwardly join.

Kendon does not use dotted outlines for any other part of the body apart from a selection of hands and arms. However, throughout this extract the subject's body postures are changing significantly. Therefore, interesting aspects of arm, shoulder, and head position are omitted due to this stylistic simplification.

Kendon augments two-stage visual panels with hand-drawn arrows designed to convey a mix of information:

- The thicker tail-end represents the longest part of the duration of the gesture movement, while the head is the most recent.
- Varying tapering effects in arrows show or imply movement speed and rates of acceleration.
- Folding, and varying the thickness of the arrow, visually summarise the spatio-temporal changes.

4.0.3 Reconstructions: Following McNeill



[thats] / the / opening of the door [is actually here]
.........(a)..(b).......................(c)
Deictic: points with tip of pen to a point on the paper in the centre space mid level.
Iconic: outlines a rapid rectangular shape at a point above this.

(a). points and holds pens at the paper surface.
(b). lifts pen upwards into open centre-centre space without changing hand.
(c). at this point traces a rectangular pathway by moving the pen towards himself, and then downwards, and finally back in the direction of the original upward pathway. Some ellipsis of the movement occurs, before retraction to edge of tabletop.

Figure 4.4:

The layering of deixis and iconicity. A small fragment of the excerpt has been reconstructed using speech that is highlighted in bold text, and square-bracketed to indicate the passages that are co-occurring with gesture. A three-point list is given (a-c). This summarises each layer (or 'channel') on a new line. The speech-gesture unit, taken as an atomised part of a larger whole, is layered with semantic meanings: (a) refers to how deixis is demonstated; (b) how the iconic content is enacted, describing the framing of this within a specific category of personal gesture space called 'center-center' (sic); (c) describes the unit's dynamics. McNeill tends to focus upon smaller segments of gesture in detail, bringing his theoretical concepts to bear on it in great detail.

A line-drawn figure with no shading has been traced from the video. It shows two stages of the arm movement at full reach. These have been superimposed without line-breaks, and sequence is indicated with the arrow direction, removing the need for ghosting and other effects. The arrow style is medium-bold in weight, so as to differentiate it from the rest of the drawing. It abstracts a complex multi-dimensional movement into a three-line jointed vector, resulting in the same kind of restriction that was seen in Kendon's reconstruction above, where the inscription of qualitative space is primarily textual and visually flattened.

McNeill very infrequently represents a second figure in his visualisations, the focus is upon the solo figure, and the experimental interlocutor remains unrepresented. McNeill alludes to another figure's actions and speech only within the associated transcript and the descriptive terms in captions and writing. His published graphics are limited to the momentary productions of the gesture-speech units of a solo figure.

In common with other vector-based representations, this illustration offers no clue as to the horizontal or vertical orientation of the rectangular shape drawn in the air by **B**. It is only with difficulty that we might determine whether it is directed towards architect **C**'s line of vision or elsewhere, for example. The movement could equally well be a triangular shape whose point extends away from the reader. The transcript is intended to remove potential ambiguities such as these, by describing the pathway in some detail.

McNeill's drawings have been produced by his own doctoral students. For example, Fey Parrill, who continues to produce similar drawings in her own research on 'catchment' (Fig. 2.23). These illustrations exhibit a sparse and layered style that is consistent across publications, encapsulating the main themes of the research, and carrying the theoretical structure with them.

4.0.4 Reconstructions: Following Goodwin

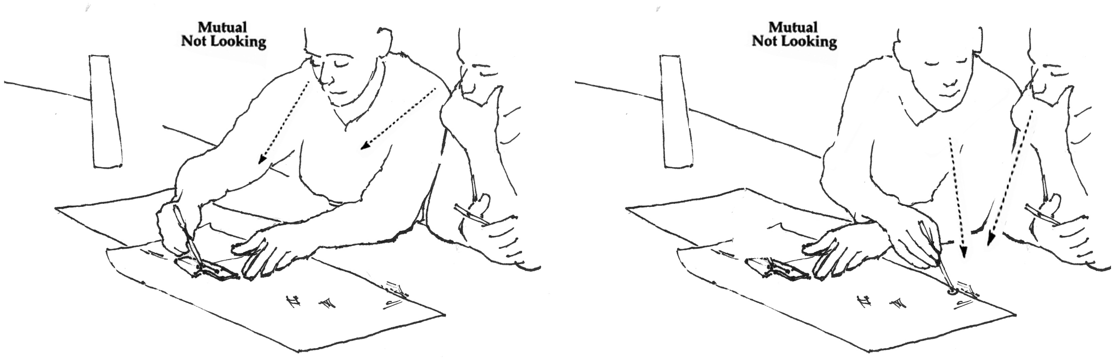


Figure 4.5: **A**: ((*continues drawing, ss1*)) you can drop the door / so that youve got // that zone there / is all open and free //

Joint attention. This reconstruction, relating to an earlier section of the excerpt, enters a new dimension by the inclusion of a second person. This begins to characterise shared space more fully than the previous reconstructions. Goodwin has used arrows for sight-lines and describes where joint focus is located, combined with linear physical surroundings, as is the case in his publications (Goodwin, 2000). The effect is of directed activity while the addressee waits for the opportunity to make a contribution. Goodwin ties his drawings to highlighted transcript segments, as do McNeill and Kendon, except that specific phrases are connected to the relevant panels by lines, indicating the transition point between the frames (Fig. 2.35).

The strength of this approach is the representation of joint attention and of the speech that helps to achieve it. A great deal is left to the imagination of the reader, which is not a disadvantage if the aim is to show global changes in the interaction. However, as soon as a more detailed topology of the interaction is required, and as soon as 'catchment', for example, and other qualitative phenomena that require visualisation, this graphical approach will be found to lack sufficient grammar to express these.

4.0.5 Reconstructions: Following Emmorey

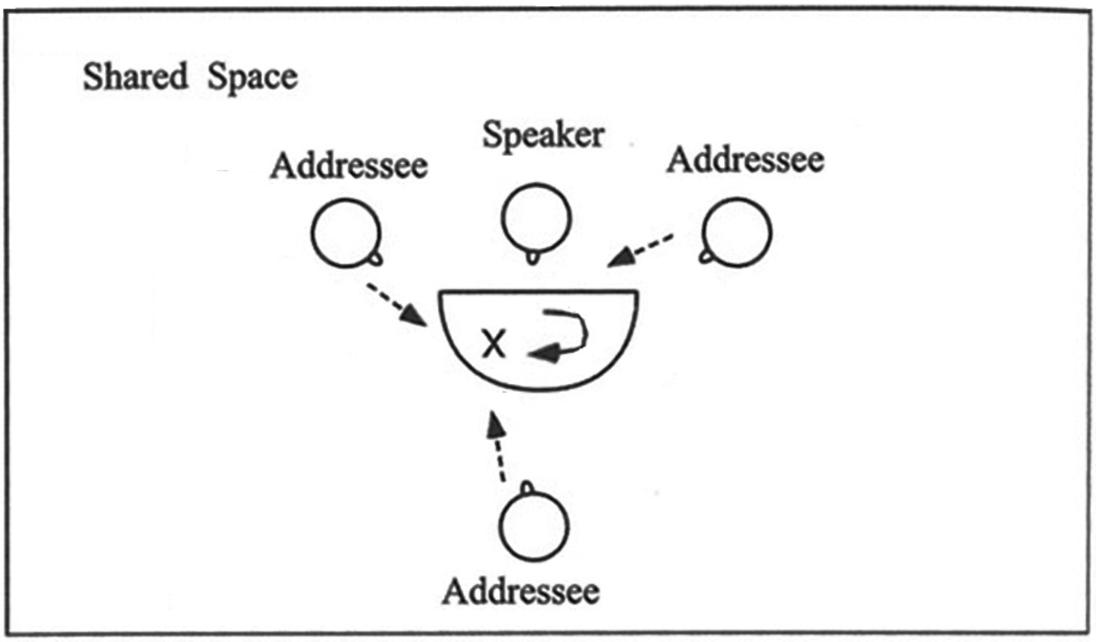


FIG.
examples of the use of shared space for nonpresent referents. The half circles represent signing space, The dotted arrow indicates the direction of a pointing sign used by the addressee .

Figure 4.6: Reconstruction of the data extract.

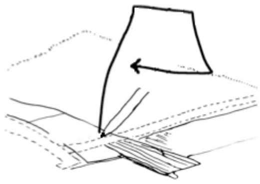
Shared topologies. Turn 20 has been redrawn following Emmorey's conventions, and is in fact an adapted version of her original diagram (Emmorey and Reilly, 1995, see Fig.2.46). These are intended to convey the conceptual schema in operation rather than specific empirical observations. In the original diagram the content is entirely schematic and has none of the carefully organised layout that other diagrammatic overhead views made by Kendon and others to summarise empirical data (Fig. 2.6). However, in contrast to the previous reconstructions, the outlined space where space is shared for the first time introduces the possibility of drawing these in more detail as zones of joint attention and spatial topic management.

The schematic view shown here reduces the physical context to a bare presence, while the heads and noses of the individuals convey scale and mutual alignment. Emmorey's original drawing distinguishes between close interaction (overlapping semi-circles) and more distant interactions (dotted arrows indicating the deictic contributions of addressees).

The short curved arrow in solid line represents the gesture above the table made by **B**. Next to it is an 'X' that denotes the non-present referent (in this case, the gestural artefact standing for the 'space above the door' within the notional building design). With further refinement, this graphic vocabulary could be developed into a fully-fledged language for non-schematic representations of empirically observed shared spaces. This is evidenced in her own non-schematic drawings using perspectival figurative space (Fig. 2.45). Emmorey's interest is in signing-languages, hence the semi-circular 'signing space' directly in front of the speaker. This is a noticeably broader space than is implied by McNeill's 'shallow disk' schema (Sect. 2.1.1).

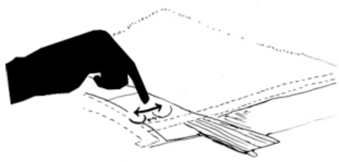
4.0.6 Reconstructions: Following Murphy

18	Red	thats not great because=	Points with pen towards the printed section on the table and at the plan next to it.
19	Purple	=[Hmm]	
			Red moves away from the section towards the plan and back again before reaching it.
20	Red	[thats] (.) the (.) opening over the door [is actually here]= (0.5)	



Red traces a rectangle in the air above the printed section on the table with the tip of his pen.

21	Blue	=[you've got that as well]	Blue points with fingertip while moving his finger along small section of an axis on the section.



22	Green	youve got that above it, yeah (.)	Uses pen tip to point and draw on the section.

Figure 4.7: Turns 18-22. The data extract reconstructed according to the conventions of Murphy, 2005. The transcript: Red, Purple, Blue, and Green, relate to architects **B**, **C**, **D**, and **A**.

'Situated Nodes of Imagining.' With this reconstruction of the extract we enter ethnographic territory, where close empirical observation is a central focus. It is not possible to create a detailed perspectival view of the paper subspaces of the present data extract. It is possible to generate a low-resolution facsimile of parts of the paper subspaces, approximating the degree of detail used in the original representation (Murphy, 2005). This is sufficient to provide an overview of the interaction by showing where and when these spaces are being indexed.

Each of the speech Turns is assigned a separate image or textual representation. The advantage of this approach is that the spaces are identified and tracked quite easily, but the disadvantage is that overlapping and joint productions are difficult to represent. Furthermore, the dependency of these conventions on detailed environmental information, some of which is telescopically accessed in detailed views, leads to a lack of spatial and temporal continuity. Consequently, increased effort is required to process the representation. While the reconstruction is evocative of the interaction, the ability to spread information across identically framed panels is lost.

The reconstruction according to Murphy's conventions suffer from spatial ambiguities brought about by reduced vector-based representations. At Turn 20 it is not clear whether the arrow is moving away from or towards the reader. The problem of accurately determining spaces is not helped by the use of silhouetted hands. These tend to emphasise planarity rather than depth and could not separate out several potentially intermingled hands in the same view. The use of shadows might have indicated where movement takes place (shadows cueing perceptual depth information are somewhat under-utilised in the literature). These issues are not helped by Murphy's convention that drawings and photographic images are of approximately the same size on the page. At Turn 20-1 **D**'s pointing gesture is not readily visible in the small video thumbnail image. This requires an adjacent drawing showing more detail. These are problems encountered by some of the previous reconstructions.

An interpretative rendering of qualitative topologies is not facilitated by Murphy's graphic conventions, as far as can be judged from the way they have been developed. By comparison, Emmorey's drawings are easier to grasp, and contain an opportunity to develop a detailed view of these topologies.

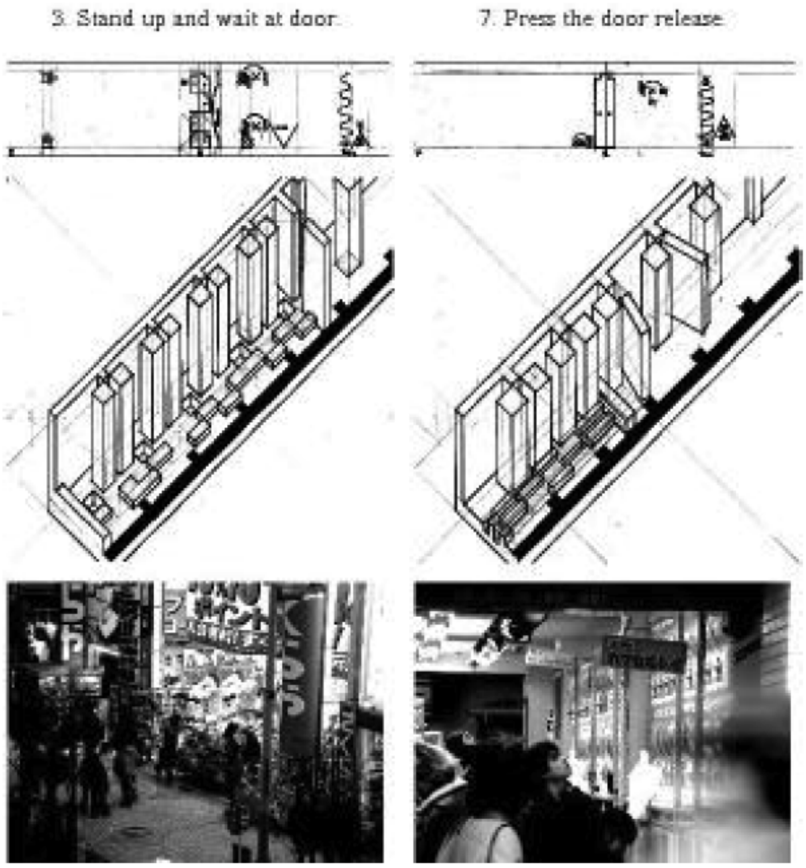


Figure 5: examples of assembled pages with diagram, notation, drawing and photograph.

Figure 4.8: **Ray Lucas, 2009.** Figure 5, representing qualitative space on the Tokyo subway.

4.0.7 Reconstructions: Following Lucas

Notation and drawing. An intriguing reconstruction of qualitative space has been devised by researcher and trained architect Ray Lucas. This is a highly specialised combination of diagram, Laban dance notation, architectural drawing, and photography. The technique seeks to 'inscribe the city' as experienced on the Tokyo metro system. Specifically, these were 30 events from a journey through a Tokyo main-line station, Shinjuku. It is not clear whether Lucas represents the experience of one person, or a collective experience. In either case the techniques are of interest.

Lucas's linear staffs of notated movement are painstakingly transformed by hand into axonometric perspective drawings, giving them a three-dimensional and apparently architectural quality (Fig. 4.8). The initially flattened phrases of notation become 'corridor archetype drawings,' aimed at 'understanding the experience more fully... a learning process' (Lucas, 2009, p.10). Each 'stop' in the continuous experience of passing through the station becomes a discrete and faceted building-block in the final rendition, resembling openings, doorways, and partitions segmenting this corridor.

Unfortunately, it is not possible to repeat this technique for the purposes of reconstructing the present data extract. Lucas's drawing conventions (or practices) require specialised knowledge and time-consuming rehearsal. This is not to detract from this approach, which could conceivably be transferred into the domain of collaborative human interaction. It has previously been noted that dance notation transcribes qualitative spaces (Sect. 1.5.1). Lucas depicts a multi-dimensional experience as a corridor, augmented by 'lateral' events, distractions caused by signage, negotiations of spaces through and against crowds, all of which is recorded in drawings and photographs. For now, the possibilities of this approach are to be noted and put to one side.

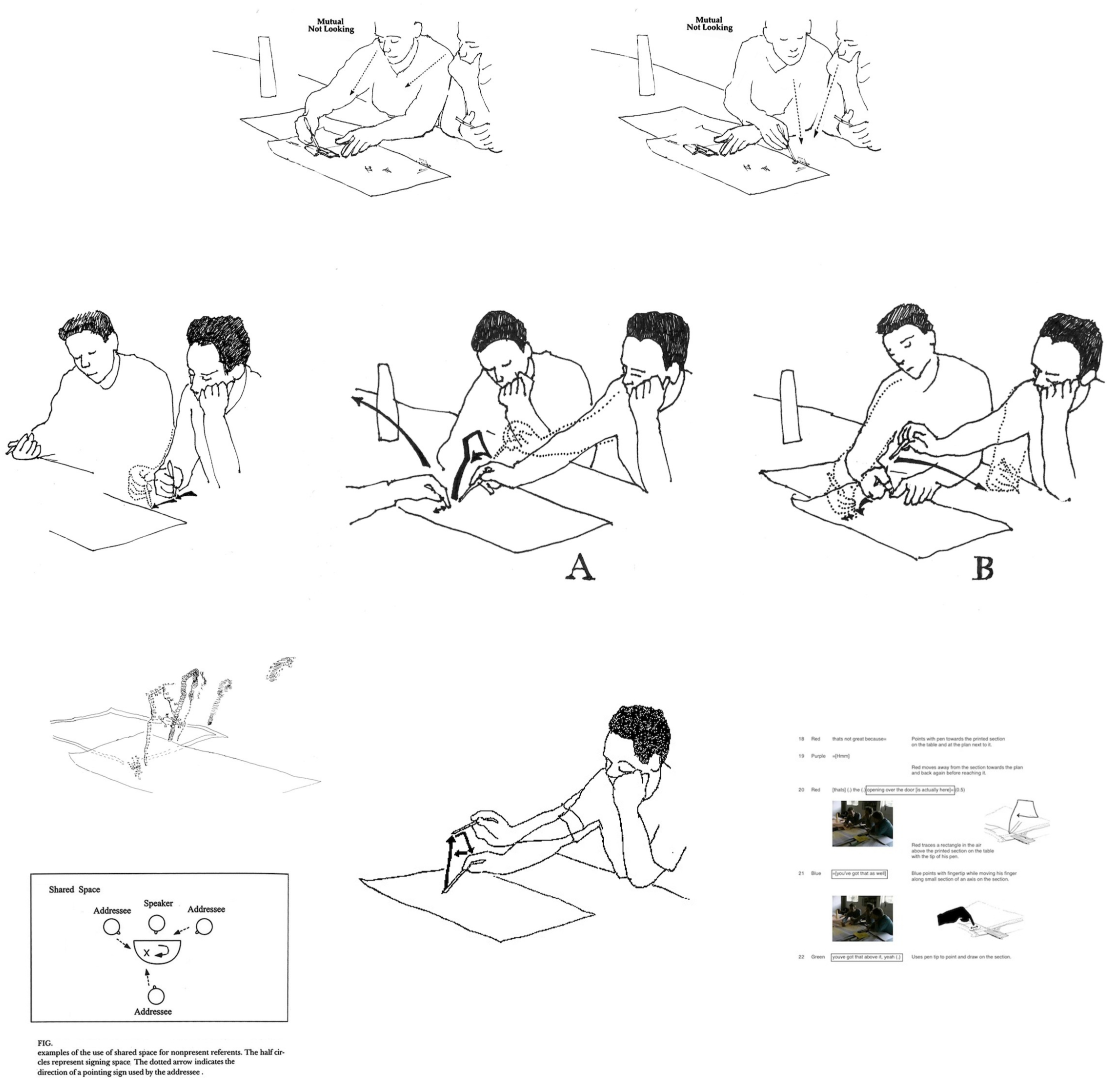


Figure 4.9: The excerpt pastiches, or reconstructions. From top to bottom and left to right: approximately following the order of the excerpt and the conventions of Goodwin, Kendon, Efron, Emmorey, McNeill, and Murphy.

4.1 Summary: the omission of qualitative space

The omission of qualitative space is noticeable in all or most of these reconstructions. Below are listed some of the features of this omission, and assumptions about qualitative space that are demonstrated by the reconstructions.

- A great deal of mental processing is required in order to deduce an accurate picture of events from combining static and textual representations, requiring demanding operations of interpretation for a low level of certainty in some cases (Fig. 4.0.2, and 4.4).
- A number of the formalisms show one gesture-speech unit at any given time. This is an outcome produceed by the structure of laboratory experiments. Subjects addressed a tripod-mounted camera while recounting a cartoon storyline, and true interaction was not the target concept.
- Efron's conventions for visuo-kinetic space (Fig. 4.3) visualise the tip of the architect's pen in the act of establishing a region of extended or projected personal space, and repositioning the referents 'here' and 'there' in different parts of the designs (Sect. 2.1.5). The spatial accuracy of this approach suggests that it is suitable for describing joint gesture production, referred to by Furuyama, but not visualised by him (Sect. 2.2.10). The approach could be extended to a host of other types of phenomena in shared space.
- Most of the approaches reconstructed in this chapter would struggle to represent the interactional aspects of the identified chain of deixis, or visuospatial imagery, a key facet of the data excerpt (Sect. 3.4.0.6).
- There would also be difficulty in determining which spaces are being referred to, because of the lack of detail in them, and also because of the difficulty in reading depth information from the line drawings.
- The reconstructions of the architectural meeting data maintain the opposition between stasis and movement, between the still-point and time-series. In them there is no hint of

> entities that fall into neither category, that are neither purely physical nor purely social constructs. These are what have been called 'fiat boundaries' (Smith and Varzi, 2010), or even 'quasi-objects' (Serres, 1995).

Since the Greek age the representation of movement has been a matter of choosing which moments to focus upon selected from a continuous series of movements (Streeck, 2009). Interaction is fleeting, but video now has captured it, slowed it down and replayed it as many times as we see fit. Some have taken this opportunity to the furthest limits of microanalysis (Condon and Sander, 1974). Despite these technological advances, researchers still choose to draw interaction, with the aim of explicating their discoveries.

Video stills of interaction provide a repository of information, arguably as complete a record of the context as is practically attainable by researchers. A large number of stills are required to depict actions (Fig. 4.10). The authors discussed here use drawings because they hope to extract a specific interpretation from the more comprehensive record. Very often this reading of the material concerns the development of shared or common space as a phenomenon. Video stills on their own are not adequate to representing this dimension of interaction. Kendon, Goodwin, McNeil, and others, highlight these phenomena but do not represent them directly.

Figure 4.10: A composite view of the chain of deixis made with video stills. Each of these stills shows a tiny proportion of the interaction, and reminds that drawings are able to summarise complex events.

4.2 Setting the scene for further work: the popular depiction of dynamics

These pastiches, or reconstructions, wrestle with different aspects of the same problem, that of finding the best static means to represent continuous movements and the communication that centres on this. The contemporary discussion of how to formalise patterns of 'catchment' can be likened to the ancient Greek concern with representing dance through the 'stops' that were incorporated into it. These were called '*rhythmoi*' or patterns isolated within continuous movement. 'Rhythmos gave rational order to motion' (Pollitt, 1972, pp. 568). Modern authors also aim to organise the dynamics within their data.

These are recent and distant clues as to why certain drawing conventions for representing movement have gained traction in the literature. Motion lines, dashed shapes, arrows, and a variety of ways if indicating vectors have been used in the literature, against a cultural backdrop where they are also in common use in comics, film, art, and graphical art. A full typology from the literature is given elsewhere (Appendix. D).

4.2.0.1 ***Movement in comics***

Figure 4.11: **Mort Meskin, 1944.** 'Johnny Quick' building a wall. Earlier stages have been placed uniformly 'below' those that are following, without the use of transparency, shading, or broken outlines to indicate temporal sequence. From 'More Fun Comics No.96' March-April.

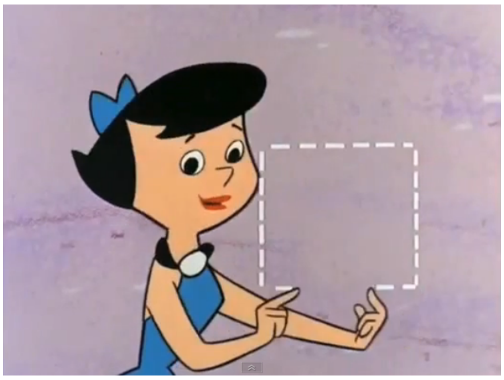


Figure 4.12: **Wilma Flintstone, 1960.** 'Fred is a square'. Hanna Barbera Productions/Warner Brothers.

Popular comic art from the mid-20th century (Fig. 4.12) have left a traceable imprint upon the way in which gesture is represented in contemporary culture and film (Tarantino et al., 1994, see Fig. 4.13). Comic book artists are not restricted to showing motion in successive static panels. Mort Meskin devised methods of overlaying motion in a single panel to convey extreme speed (Fig. 4.11). Infantino Carmine developed the use of 'zip-lines' to represent motion (Amash et al., 2010). These art-forms have helped to establish a series of generally understood conventions for movement, while necessarily and efficiently limiting their storyline to a small number of panels (McCloud, 1994, and Cutting, 2002). Arrows and lines with varying qualities have featured strongly in the majority of line drawings in the literature seeking to convey the direction and speed of gestural movement.

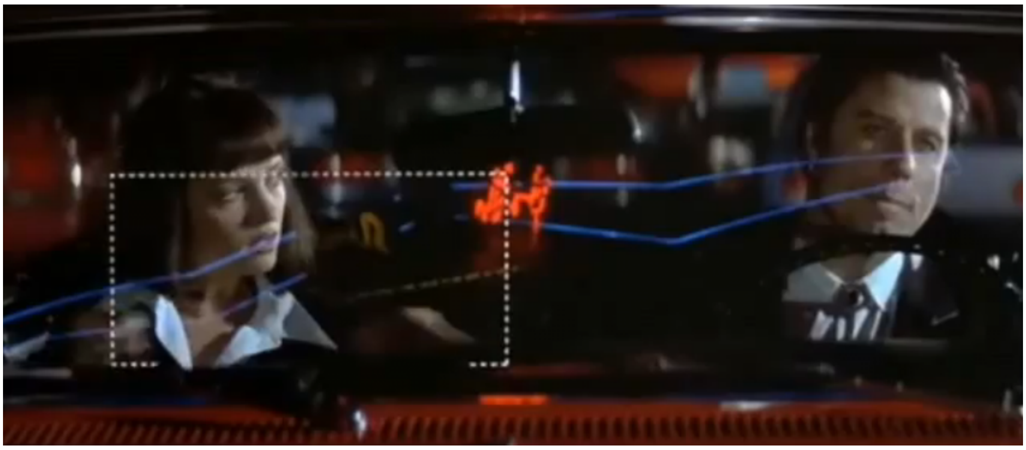


Figure 4.13: **Quentin Tarrantino,, 1994.** The character Mia Wallace in the feature film ‘Pulp Fiction’: “Don’t be a ......”, drawing a rectangle in the air.

4.2.0.2 Movement in early art

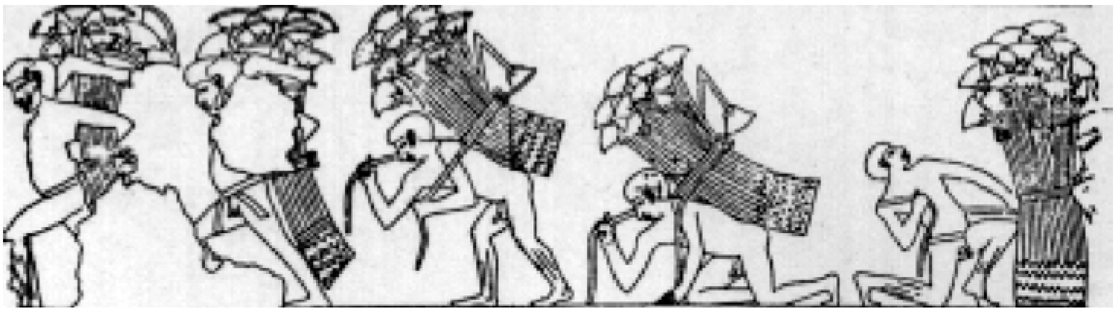


Figure 4.14: **Streeck, 2009.** An agricultural labourer lifting a hay bundle.

Streeck is one of the few researchers in human interaction to have written extensively about the visuality of interaction and its depiction. His own representations are single line-drawn panels with a transcript that is bullet-pointed at the part of the speech that relates to the gesture seen in the drawing (Streeck et al., 2009, see Fig. 4.15. He notes that since the introduction of time-series and psychological motivations into the picturing of gesture, ‘an idiosyncratic iconic depiction [contained in gesture] cumulatively conveyed by a series of motions over time does not translate well into a picture’ (Streeck, 2009, p.12). As a result it became important to choose the particular moment of representation carefully. The importance of this has also been stressed in a following chapter (Chapter. 6). Streeck's message is that a singular well-chosen and appositely framed image is more likely to capture an idiosyncratic iconic gesture.

Streeck's example is an ancient Egyptian worker lifting a bundle of hay onto his back. This is shown in successive stages and thus beginning the historical process of breaking the action down into 'ever-smaller component acts.' The process of atomisation has since been developed photographically (Muybridge, 1955, and Gilbreth, 1911) and digitally with motion-capture technology (Battersby, 2011). The original 'conceptual unity' of the motion cannot then be recovered and this leads to a continual 'recursive process' in the depiction of movement.

This Egyptian labourer is a time-series, whereas a modern comic-book heroic figure builds a wall at great speed within one panel (Fig. 4.11). The conceptual unity of the carrying action is given by the semantic and cultural context of the small-multiple, ensuring that it is interpreted correctly and read in the right direction. In these examples, the specific context is building and lifting, rather than the acts of deconstructing and putting-down. The framing device, either a small-multiple or the single panel compressing several views of the action, is intended to carry the unity of the actions across its several parts. The principle to be carried forward into further work is that a singular image should be preferred: one that does not contain short-cuts to representing action, such as arrows, ghosting, and other devices. It remains to be seen in a following chapter whether such an image is capable of representing phenomena as dynamic and temporally and spatially dispersed as a cohesive chain of catchment for example (Chapter. 5).

4.3 Conclusion

Authors most often use drawings in their exegesis to illustrate or expand points in an argument, but also to facilitate access to the data. Ozyurek and Efron refer to the fact that drawing is a method for finding data, irrespective of whether drawings are published (Sect. 2.2.12.1). Efron built an armature, a rotating brass 'arm' that stood in for foreshortened limbs captured on film. The shadows were then traced in order to establish the positions of arms in relation to the torso, and *manubrium* (Appendix C). He did so because the data would have been impossible to access in any other way, in the absence of digital 3d tools, and the process was also a way of cross-checking whether purely visual estimation was to be trusted (it was).

A survey of the journal *Gesture* revealed that composites of video frames and drawing were almost as prevalent as screen-shots of video annotation software (Table. 1.1). These composites were found in connection with topics such as the planned and unplanned use of gesture space in mathematical and physics instruction. Authors processed photographic stills by digitally drawing into them (Ochs et al., 1996, Núñez, 2004, Núñez, 2008, Yoon et al., 2009, and Yoon et al., 2011). This strategy was chosen to represent qualitatively organised spaces, specifically those that are not visible in photographic and video evidence. The approach is especially valuable in contexts where the interaction relates to abstract topics that are placed into shared spaces. Yoon digitally inscribes upon a single video frame with line to show how a student completes the instructor's gesture and thereby solves the posed mathematical problem (Fig. 2.49).

Collaborative work in mathematical gesture space deploys abstract physically non-present referents that are placed into a physical space during interaction. Popular culture informs the academic use of arrows and dashes to show movement, and it should also be on hand to assist authors with the representation of abstract and topical content that is placed into and manipulated within shared space. The spectacle of Wilma Flintstone (voice-acted by Jean Vander Pyl) and Mia Wallace (played by Uma Thurman) drawing dashed squares in the air with their fingers, literally marks out loops of space, ensuring that their message is seen as well as heard (Figs. 4.12, and 4.13). Exploratory drawings of this same data extract will test the usability of such looped outlines of fields of space, in conjunction with with simple line-drawn human figures (Chapter. 5).

5.5 Cita and Cito

Cito 1 Di mabalin kay' latta nga agpadanum ditoyen.
So you can water here just like that.

Cita 2 Wen, diretso adiay • danum nukua. Adda met ittan bandana'
Yes, the water comes directly here. There are also channels

Figure 4.15: **Streeck, 2009.** A drawing illustrating the gesture accompanying speech: 'channels of water.' Note the link to online video data, at top left.

Chapter 5

Reconceptualising shared space with drawing

5.1 Outstanding questions and requirements.

A number of pivotal representational issues have been raised by the previous chapters, and are summarised in this section. They highlight the present inadequacies of representations of human interaction in the literature. The reconstructions of the sample case study data (Ch. 3) revealed the visual implications of these requirements, or outstanding issues. The remainder of the present chapter will look at how they should be dealt with when representing the same data sample.

5.1.1 Requirement: Time

Representing the expansions and contractions of topical qualitative spaces is therefore a primary target of the drawing techniques set forth here. Depending on how they have been constructed, inscriptions of shared spaces will appear and disappear, and possibly reappear over the duration of an interaction. Boundaries as they change over time should be captured in a series of related drawings. The process of inscription also conveys failed or delayed gesture, abortive preparations, and retractions, if these are central to the particular interaction. These are consequential when framing an overall understanding of interactional events and discourse.

5.1.2 Requirement: Articulating the *o-space*

Kendon's concept of the *o-space* plays an important role as a jumping-off point in the development of new visual formulations for qualitative space. The organising effect of the o-space was originally couched in terms of its 'framing' of interaction (Kendon, 1990). According to Kendon the positioning of a participant's foot, lower body, and torso when standing, are key to establishing the structure of schematised qualitative spaces. This is a suitable place to begin further refinements. The drawings reproduced in this chapter examine the possibilities of articulating finer sub-structures within this o-space. This is firstly in terms of body-centric criteria (including reach space and peripersonal space), and secondly, in terms of jointly manufactured and maintained spaces.

5.1.3 Requirement: Spatio-temporal catchment

The example given above, where Parrill and Sweetser's representations are redrawn, suggest temporally dispersed gestural 'catchments'. As stated before, these successively build upon one another to provide discourse unity, or thematic cohesion. Any representational technique that can provide a richer description of this is to be welcomed, especially if it leads to a further questioning and refinement of the analytic concepts.

The different panels of the original time-series have been traced, reducing the series to two drawings instead of four. This emphasises the action of the hands in their shaping of space, contrasted over time (essential attributes of catchment). This does not improve the readability of the drawing, however (Fig. 5.1). Another re-drawing separates out the same information as is seen is the previous redrawing's right-hand side. Here, readability is improved, and there is a resultant opportunity to shape a visual interpretation of the gestures: dotted lines have been added to show an interpretation of how the hands are creating shapes from 'empty' space. This was an exploratory study that suggested the possibility that 'catchment' can be recast in terms of the modulation of space.

5.1.4 Requirement: Representing joint gestures

Cases where two people jointly manufacture and maintain shared gesture space, present an interesting representational problem. The sample data clip from the architects meetings contains such jointly managed spaces. Two colleagues work on the same problem, resulting in **B**'s aerial gesture, which is founded upon their joint speech and actions, and their shared micro-management of the workspace. (Turns 19-20, Sect. 3.3.0.3, for a detailed description of this). Another question, concerning how to represent gesture-completion by a second person, was identified in the literature (Sect. 2.2.9). Turns 19-20 are examples of gesture-extension, or a development upon, rather than simply a completion of someones unfinished gesture (See Appendix. A.0.2.19).

5.1.5 Requirement: Boundary phenomena

The term boundary phenomenon here refers to those objects and events located at the edges of the identified zones of interest. They also have a role in finding and determining those edges, by helping to establish where that area of interest ceases to be and another begins. They can also be created by these boundaries. They can have physical and symbolic functions in social and psychological space. The term is found in the physical sciences, and disciplines such as psychotherapeutic topology (Burgoyne, 2000), sociology (Shotter, 1993, and Hicks, 1994), and geography (where manufactured *'fiat'* boundaries are different in kind to *'bona fide'*, or naturally occurring ones, (Smith, 1995, Smith and Varzi, 2010, and Smith and Varzi, 1997, p.4, quoted below):

> Kisses, handshakes, and other similar entities are to this extent creatures of the *fiat* world.

Many of the drawings discussed in this thesis demonstrate the life-drawing concept of *negative space* (Chamberlain et al., 2011) as it has been applied to drawings of boundaries in human interaction. This application of this concept has contributed directly towards the development of a hypothesis concerning the role of 'negative' (or rather, 'empty') spaces in analysing collaborative shared space. Boundaries are determined by a combination of i). hands engaged in gesture and other activities such as drawing, ii). resting hands, and iii). other contributing factors related to posture, and gaze. The possibility that empty space plays an important role in understanding shared space, leads naturally to experimentation with alternative ways to organise its structure with drawing processes.

5.1.6 Requirement: Gaze patterns

In contexts such as the multiparty architect's meetings gaze direction is not always easy to detect. Indeterminacy of gaze might be considered as an obstacle in many areas of research into human interaction. However, describing gaze pattern is not intrinsically related to representing spaces that are manufactured and then managed in particular by speech, hands, and posture. The highly complex relationships between gaze directions in a multiparty meeting can be seen in a number of the drawings based upon different data, and are seen in the following chapter (Fig. 6.4). Future extension of the present work is required to take account of the effects of gaze upon qualitative spaces (Sect. 7.2.1). We previously saw how the *Synchronous Objects* project classed gaze as unhelpful when representing shared space (1.5.1).

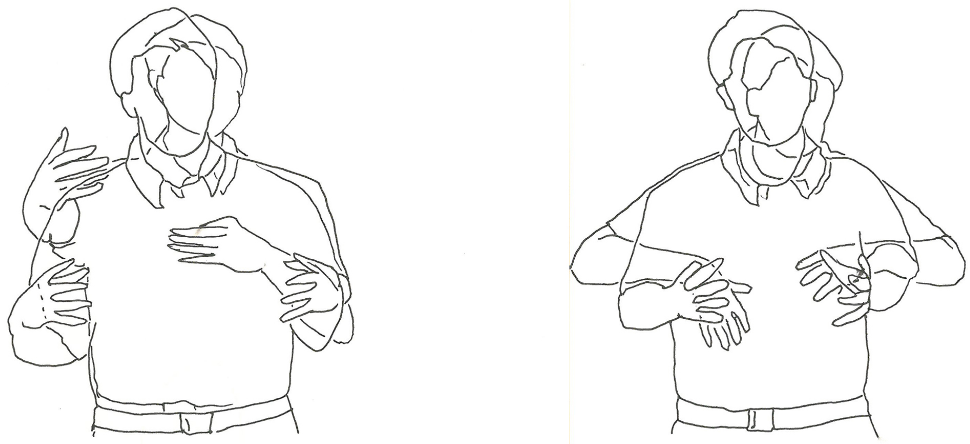


Figure 5.1: Re-drawings of catchment, using broken line to represent layering of the sequence. Based on Parrill and Sweetser.

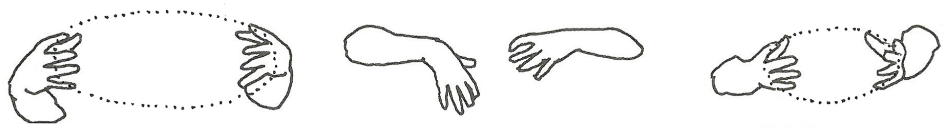


Figure 5.2: Adapted and re-drawn catchment, showing how at certain points in time a person's hands actively 'sculpt' areas of space. Based on Parrill and Sweetser.

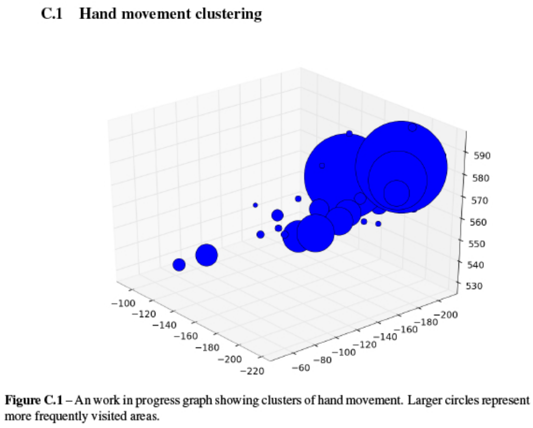


Figure 5.3: **Battersby, 2011.** PhD thesis, a graph representing clustering effects in motion-captured multiparty interactional data.

5.2 Introducing a drawing methodology

The focus of this work is upon developing a method that attempts to meet the criteria set out above. The aim is to identify how drawing can help to uncover and visually represent the qualitative structure of shared space. This especially concerns those types of collaborative interactions that have eluded evocative representation to date (Sect. 5.1).

Technique is a matter of finding the correct balance between these means of production so that appropriate conceptual content can be represented. The rationale behind the methodology is described in some detail in the following sections (Sect. 5.4.2) This rationale is key to how the techniques can be understood and subsequently re-applied by others. Technique is therefore not only a matter of mastery over the technical or mechanical means of production, and reproduction. Instead, the notion of technique is here closer to Latour's concept of inscription devices, where a drawing 'device' is not merely a physical arrangement such as a drawing board and pen, for example. This is an (often professional) practice that is embedded in a range of beliefs and attitudes, that surround, support, and develop the use of particular methods in particular circumstances (Latour, 1986, and Law, 2004).

Richness in a picture of interaction can be indexed by the quantity of information presented, but it can also be measured against the information that has been left out. It has been argued that a representation is greatly enhanced by efficiency in its use of *data-ink* (Glossary A.0.2.15). This can be achieved by a judicious reduction in the number of data-points that need to be processed by a viewer, without any reduction in its informational content (Tufte and Graves-Morris, 1983b).

When constructing *time-series* (Glossary **??**), bodily and situational cues can be used to establish a spatial frame of reference for qualitative spaces. For the sake of clarity and brevity these cues can sometimes be removed from successive frames of a time-series sequence, without any loss in information and descriptive power. If scale and viewpoint persist, a *small multiple* (Glossary A.0.2.14) need not repeat details if there is no change to report and if they are not essential to the series, since a natural assumption will be made as to the persistence of that item.

5.3 Outlining the drawing methods

All of the drawing methods described in this chapter are founded upon the close study of sequences of video frames for information about gesture paths, or 'vectors'. Novel drawings of qualitative spaces have evolved beyond an initial attention to gesture vectors on their own, encouraging line drawings to be seen as delineating pockets of space.

This invokes a small family of concepts that give shape and detail to qualitative spaces, treating them as more than paths that are seen as lines on a page:

- Field conditions.
- Negative spaces.
- Boundary phenomena.

5.3.1 Methods for sparsely representing gesture vectors

Line vectors can be drawn by following selected anatomical and other reference points frame-by-frame through the video data. This leads to a series of points recording where features are located in each frame, which can then be linked by a line. One function of the line is to make clear the order in which those points are to be read as a series. Another way of accomplishing a similar result is to follow the selected points as they move but without stopping for each frame, making the line into a continuous one, rather than set of discrete points that have been joined.

The task of tracing out these simple vectors builds a representation up from modest but essential beginnings, starting from the smallest possible unit (the point), and building from there (to the interlinking line, figure outlines, bodily and facial features). This facilitates closer observation, and with it, a familiarity with the data, as well as a confidence in initial results. It also creates the opportunity to locate phenomena that would otherwise be missed if the process of detailed observation had not been followed. The method of collating video frames and drawing from them is described in more detail later in this Chapter (Sect. 5.4.2.1).

5.3.2 Methods: Field inscriptions

The new term *field inscription* is developed here to refer to drawing practices that organise and re-conceptualise qualitative spaces, especially as drawn boundaries that can be read as volumes or fields of shared space. The aim of such inscriptions is to identify, test out, and visualise the conditions that relate to and organise these objects. Field inscriptions are especially valuable if the amount of visual ‘noise’ that groups of objects are liable to generate can be managed and reduced (making it easier to interpret the dynamics of shared spaces). Essentially, drawing identifies relationships between different aspects of an interaction, gathering them into groups, and thereby creating a visual patterning from entities that are scattered over space and time. By drawing a line around these groups, we are constructing a framework for organising qualitative space, a basic unit of analysis to use within the present research paradigm (Sect. 1.3).

5.3.2.1 ***Methods: Field conditions***

A line drawn over and around a particular instantiation of qualitative space establishes a boundary, edge, intersection, or junction, that defines the space and sets it apart from others. This is a transitory but nevertheless consequential phenomenon, which requires a framework in order to be discussed. Such a framework can be found in texts by Allen, who describes the concept of a *field condition* as 'any formal or spatial matrix capable of unifying diverse elements while respecting the identity of each' (Allen, 1996, p.2). The concept has been derived from quantum field theory (Peskin et al., 1996), which is aimed at quantifying dynamic relationships, and has from the 1950's been referred to by the social sciences (Lewin and Cartwright, 1952). A drawing methodology can be textually framed with terms expressing the dynamics of field conditions, but the present methods have been formulated without reference to formal mathematical methods. Nor are the resulting drawings to be assessed in such formal terms.

Allen says that the overall shape of the field is less important than the internal relation of parts which determine the behaviour of the field. The fields are 'loosely bound aggregates characterised by porosity and interconnectivity', and are grounded in 'intricate' local connections. And he emphasises: 'Form matters, but not so much the form of things as the forms *between* things' (Allen, 1997, p.2). Allen provides an illustration of the graphic transition between a group of objects and field conditions (Fig. 5.4). On the left, a work by the artist Mondrian is shown, as a stand-in for a given set of individual objects each with their distinct qualities. Contrasted with it on the right is a diagram borrowed from the life sciences, illustrating subdivision into concentric fields that contain these objects, but may not show them directly.

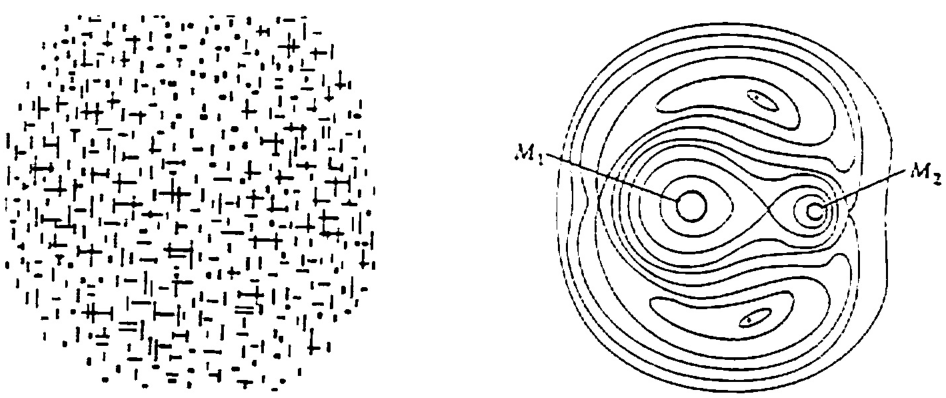


Figure 5.4: **Stan Allen, 1997.** From *Object to Field*, 1997. These diagrams do not represent the same data, but were intended to illustrate the difference between seeing data as a series of objects or as a field organised in a certain way.

A novel technique for deriving field inscriptions from video data of human interaction is described below (Sect. 5.3.2.3). This involves determining an optimal spatial boundary for a set of related phenomena, and allows us to visually represent the interactional connectivity that is observed. This concerns a technique for visually interpreting *movement coinciding in topical space*, and then *showing how these spaces are jointly manipulated and modulated.* A bounding line makes visible the hypothesised relationships within an interaction. The form of representation, a looped line (which may appear to be linear and somewhat minimal) is combined with other representational elements such as human figures, and the environment, plus possibly a transcript of speech. This results in an altogether different and richer description than would be possible by tracing physical movements on their own, for example.

*5.3.2.2 **Methods: Negative space***

By looking for the relationships between an object's edges and the edges of neighbouring objects, and by drawing these, an awareness is gained of the shapes formed by the spaces that exist between things. In conventional life drawing, attending to, and recording impressions of *negative space* admits into the drawing process new observations about scale, proportion, relative size, and position (Chamberlain et al., 2011). In following this approach, aspects of space usage in communication, that might otherwise prove difficult to place and to picture, resolve themselves automatically, or, in the process, become less prominent as analytic issues.

The concept of negative space assists in the reframing of a problem space, and has a bearing upon the research questions of this thesis. In the context of human interaction the phrase 'negative space' is potentially misleading, since it is intended to refer to spaces that are empty but are 'active' in some way during interaction. The concept 'redefines the nature of the relation between figure and ground' (Allen, 1997, p.134), or the overall compositional effect (or *gestalt*) in the way that an interaction is visualised. For example, a speaker's gesturing hands create pockets of 'empty' space, through which iconicity and metaphoricity is conveyed (Fig. 5.1, and 5.2).

5.3.2.3 ***Methods: Encircling line***

Field inscriptions are made using lines that encircle the phenomena designated as related to one another, as Allen's illustration suggests. In the context of human interaction, the transience, mobility, and fluidity of shared qualitative space, requires a drawing approach (and technique) that will represent a selection of these qualities different types of descriptive lines and shapes are suited to different types of interactional spaces, at a variety of resolutions, or levels of granularity. In order to establish groupings of empirically observed qualitative spaces, at coarser and finer levels, single looped lines have been used.

Such a descriptive line must be constrained in some way, if it is to be meaningful within the context of a social interaction. If constraints are designed to be as tight as possible, the space described will be identical with a sparsely represented gesture-pathway, or vector. In such a case, a loop is flattened to such a degree that to all intents and purposes it appears as a single line. If on the other hand the constraint is deployed expansively, it dilutes any interactional significance that might be attached to that sub-domain of space. In such a case, the looped line is cast so wide that it is indistinguishable from the more general surrounding space. Hence the aim should be to draw a line that possesses an optimal tolerance, and that can be iteratively corrected and adjusted according to empirical observations.

The working assumption is therefore made that these qualitative spaces will persist, as long as related speech and gesture contributions still pertain to and maintain the subspace. This implies that a new speech-turn altering the anchored agreements of the discourse, will also in many cases be reflected in the resulting visual inscription. Whether this assumption holds of the use of shared space in interaction in general is, of course, an empirical question that is not resolved within the scope of this thesis.

5.3.3 Methods for anchoring: body and physical environment

The contours of people's bodies and of other objects in the scene are indispensable to a reader who may not have access to the original video data. Only when human figures are added to the representations, at points where they provide context and scale to the results obtained by the above methods, will anything approaching representational richness be achieved.

Perceptual depth-cues are invaluable, supporting the drawn iterations of shared qualitative spaces. Drawings of human figures are one way of providing these cues. They maintain a consistency of scale and relationship across a specific time-series representation, enabling it to be 'read.' Speculative inscriptions of interactional spaces such as the ones discussed here, exist within and around the figures (although they need not always be seen in conjunction with human figures and their physical context). A single line showing the position of a pair of hands is often sufficient to develop the perception of relational depth amongst qualitative fields. These would otherwise be relatively abstract in appearance, and offer little empirical verisimilitude.

Methods for including transcript related information into representations were tested, mapping the speech-turns and their indexed subspaces, as graphs to supplement the drawn materials. *GraphViz* was used to devise a variety of graphs that displayed this information in different ways.[1]

[1] *www.graphviz.org* An open source graph network visualisation project, AT&T Research.

5.4 Results: Drawing explorations

5.4.1 Results: Experimenting with gesture vectors.

Using conventional methods for representing gestural vectors, that are described in detail above (Sect. 5.3.1), a number of desiderata from preceding Chapters can be taken up (Sect. 5.1.2).

‘Space-time worms’ are an approach that relates closely to the requirements detailed above for visualising time (Sect. 5.1.1). The idea is adapted from an MIT Media Lab technique, where they are also called ‘video-volumes’ (Kubat et al., 2007). They can also be compared to some technologically facilitated representations of human interaction (Fig. 2.47). These drawings exploit the perceptual capacity to displace selected data-points in one or more directions while maintaining an overall coherence, representing the events as they unfold over time. Distinctive patterns and rhythms emerge as a result (‘Time-worm’ study, Fig. 5.7). These can be interpreted with relative ease, the usage of space in communication is made quite obvious and is allied with speech in the form of text and sound wave-forms.

The weakness of this approach is that time is encoded as a linear progression from left to right, neglecting other directions in which it can be visualised. It also implies that some parts of the data will be lost, or obscured due to the chosen direction of displacement. This is because movements are shown underlying previous inscriptions and are occluded by them, (a comment pertinent to all such representations where time and events are displaced on the page, whether horizontally, vertically or otherwise). However, this can be remedied by representing data in multiple directions of displacement, if needed.

These drawings adopt a particular attitude to representing the passage of time (Sect. 5.1.2), preferring to show time as a further aspect of the physical surroundings, rather than as a separate dimension that is not directly encoded into the representation.

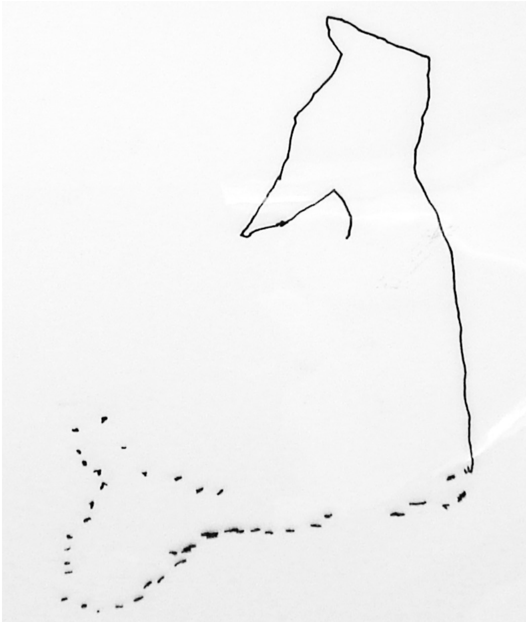


Figure 5.5: Sparse gesture vectors: Turn 20, architect B's pathway above the table and plans. The solid line shows the rising pen tip of architect **B** above the tabletop. (Below is marked the position of its shadow as it moves, for additional spatial context).

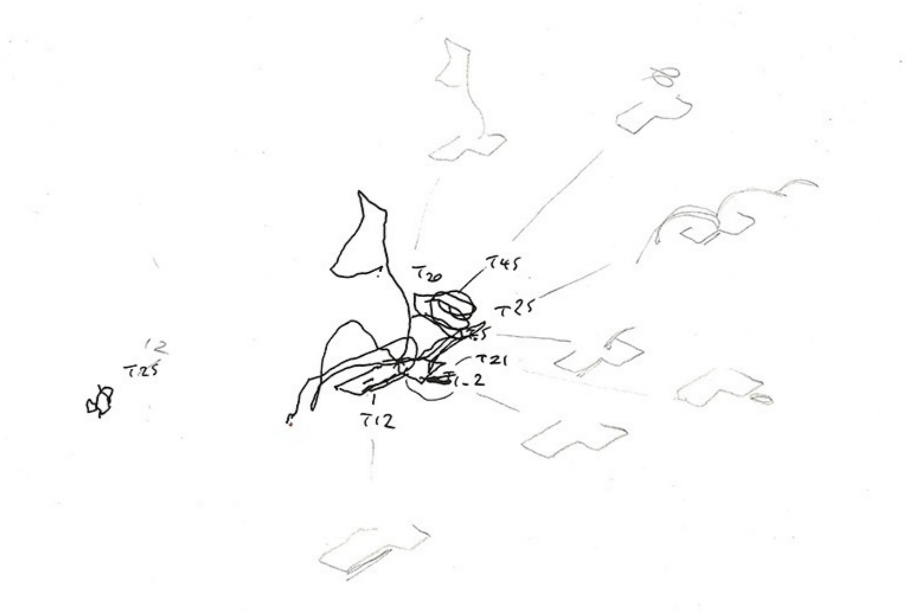


Figure 5.6: Gesture vectors become unreadable when amassed over time. Separating them out and labelling the contributions resolves this issue, at the cost of displacing the information elsewhere.

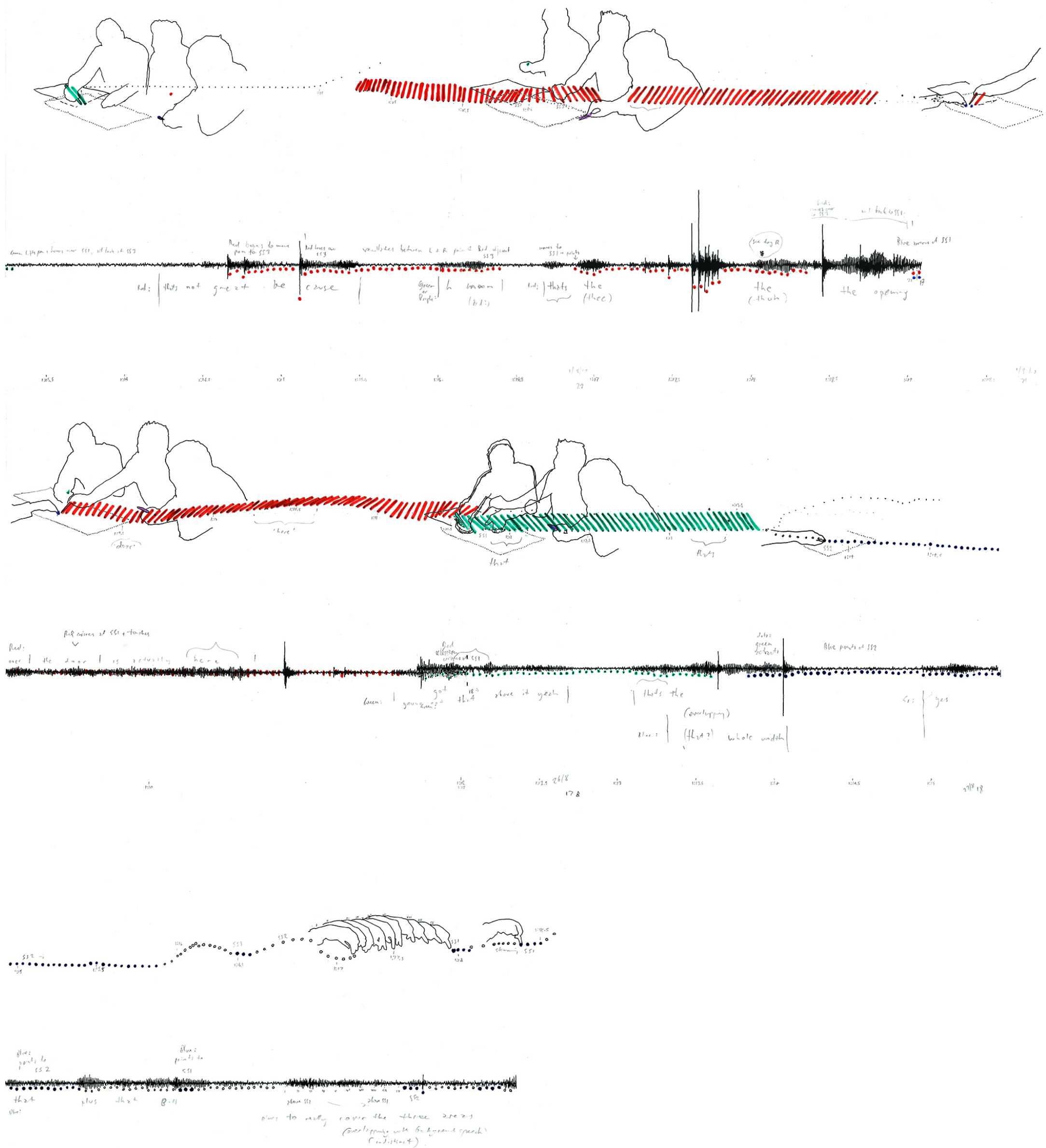


Figure 5.7: A 'space-time worm' drawing, where displacement is made in small horizontal increments following the timeline of ELAN. It also includes speech and sound waveforms, also derived from ELAN.

5.4.2 Results: Objects translated into relational fields

There is a significant representational problem concerning how to show separate temporal and spatial instances of closely related co-speech gestures. What is sought is a succinct visual expression of known theoretical interests in Catchment and discourse cohesion (Sect. 5.1.3), as well as other related phenomena that may be revealed through the process of drawing interaction. The observational process facilitated by drawing methods, should extend the theoretical debate and not simply illustrate some of its published central ideas.

A drawn solution to this difficulty of representing catchment-like phenomena, should enable the disparate qualities of contributions to be immediately compared by the researcher. Thereby visualising the ways in which speech and gesture use space to tie together conversational topics. Also identified as a requirement, is a drawing method that shows how peripheral phenomena (resting hands for example), act to frame these moments of cohesion, contributing to building a shared awareness of them across time (Sect. 5.1.5). The ability to allude in our representations to this shared spatial understanding of the group, should not be underestimated. It is this type of built-in reflexivity that is often found in interaction, and was described in previous chapter as *Deixis 2*, or gesture that points to its own place in space (Sect. 2.3.2).

5.4.2.1 ***Results: Transitional drawings***

A small series of drawings (here referred to as ‘Pathways changed to fields, drawings 1-4’) illustrates the process by which *field inscription* was arrived at and tested. These drawings established the technique of inscribing fields of qualitative space, and tested their viability by working with the data extract, testing out various applications of the method. The technique demonstrates a ‘bottom-up’ approach to the data, looking closely at video frames, as described above (Sect. 5.3.1), and immediately below.

The process begins with a careful selection of gesture vectors, and linear pathways generated from these. The selection of vectors was made on the basis of having previously identified the cohesive chain of visuospatial co-speech gesture within the data (Sect. 3.4.0.6). From there, a variety of different attempts were made to design shapes that communicated the spatial relationships between these key moments in the dialogue (Pathways changed to Fields 1, Fig. 5.8, and 5.9). These show a gradual increase in the visual clarity and economy of mark-making, due to a rising familiarity with and expertise within the data.

These drawings were predicated on maintaining a consistent representation of space across the clip showing the architect's interaction. The working assumption was that the papers on the table were to be the measure for all of the spaces, giving a basis for comparison, and that displacement laterally or otherwise would not be employed since it fractured the perceived persistence of the paper spaces and the actions around them. In other words, the data was stabilised so that each stage of the cohesive thread could be seen in comparable terms. To this end, the frames of the handheld video were painstakingly assembled and resized where necessary to accommodate differences in viewpoint and degree of zoom. This produced an *Adobe* PDF document of 382 pages. This was scrolled through, page by page, so that the spaces associated with each Turn were drawn as accurately as possible.

- T1 that zone there all the way through
- T2 is all open and free
- T5 so thats just all air
- T12 what does the elevation look like? if you were looking at the door
- T20 the opening over the door is actually here
- T 25 that plus that Bill to bring over the free air
- T34 standing at that point there
- T45 this whole thing as a kind of air scoop?

Drawing while scrolling back and forth between these pages at different speeds produced results of different kinds. For example, detailed views of the central subspaces were created, with faster scrolling that preserved the sense of movement (Pathways changed to Fields, drawings 3 and 4, Fig. 5.10, and 5.11). This series of works involved a cycle of testing and reiteration, at each stage refining the observational criteria and with regard to the outcomes of the hand-made drawings.

A noticeable quality of these drawings is their ability to capture transformations in qualitative space. They show how a flat table-orientated space becomes extended and raised in successive directions as time progresses. The concertina sketchbook format of these studies creates an impression of animated shared space, in a similar way to a flip-book of stills, or a film comprised of sequences of individual drawings (de Bruyn, 2007, see Fig. 1.12). The interest of these small sketchbooks was carried through to larger sketchbook versions of the same chain of catchment. The latter served as the basis for further work extending and re-testing these drawing methods, and are discussed in detail below (Sect. 5.5.1).

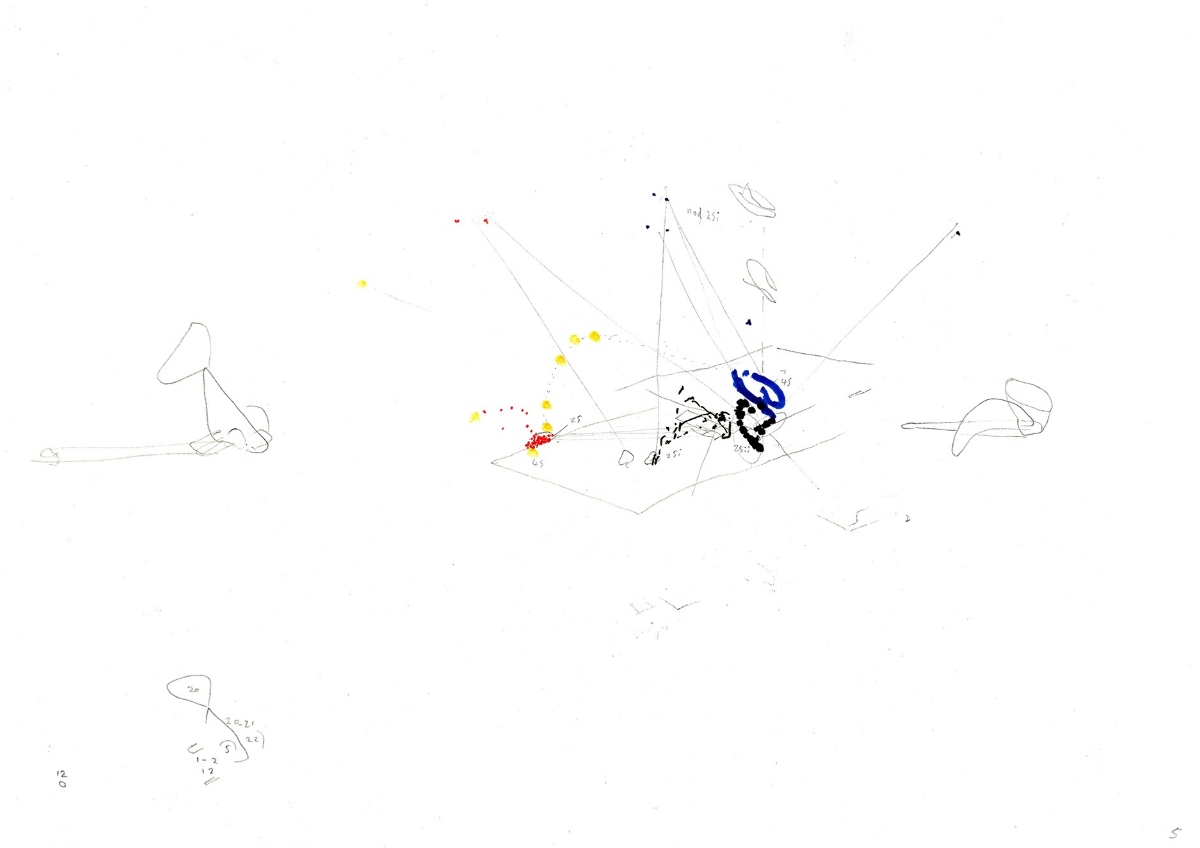


Figure 5.8: Pathways to fields, 1: different approaches to assembling and grouping the collected vectors and subspaces of the data excerpt. Note the first use of looped lines to accomplish this grouping effect around clusters of gesture vectors.

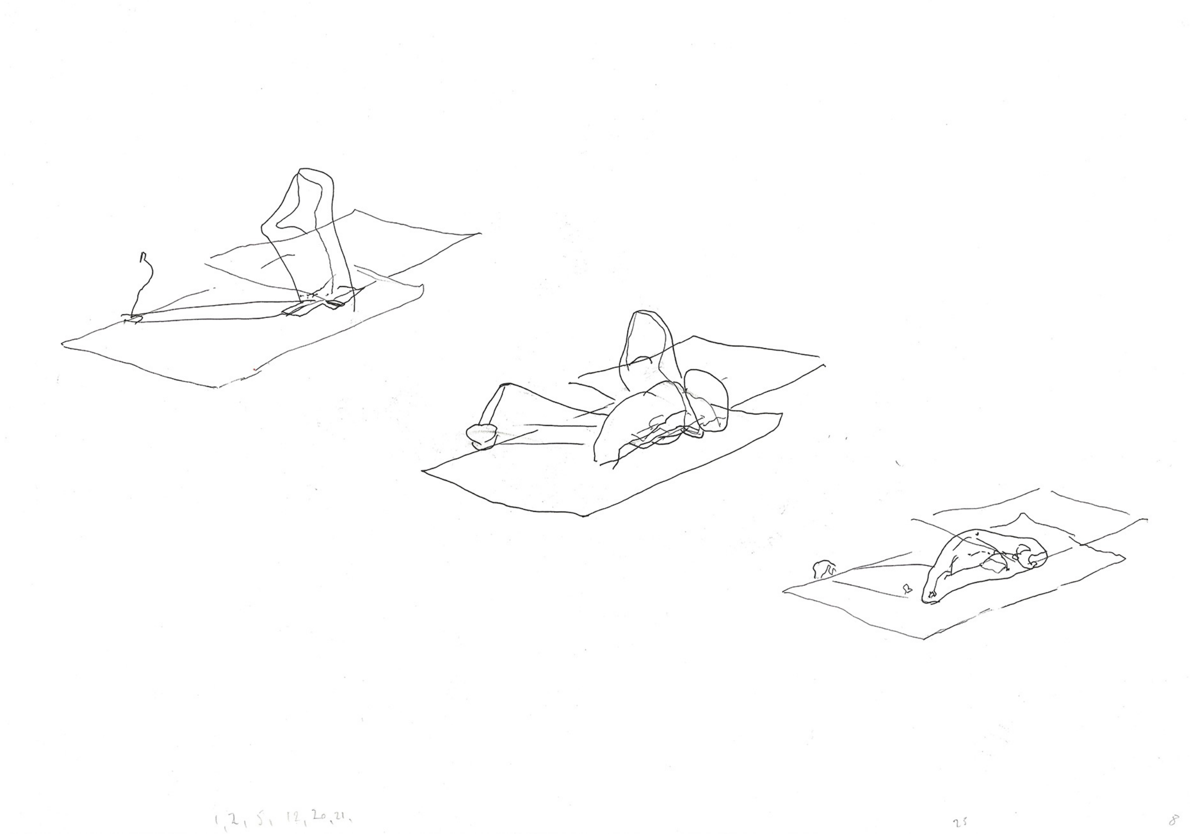


Figure 5.9: Pathways to fields, 2: developing variations of outlined qualitative spaces. Note the experimentation with alternate ways to link separate spaces, and the association of contrasted temporal passages into the drawings.

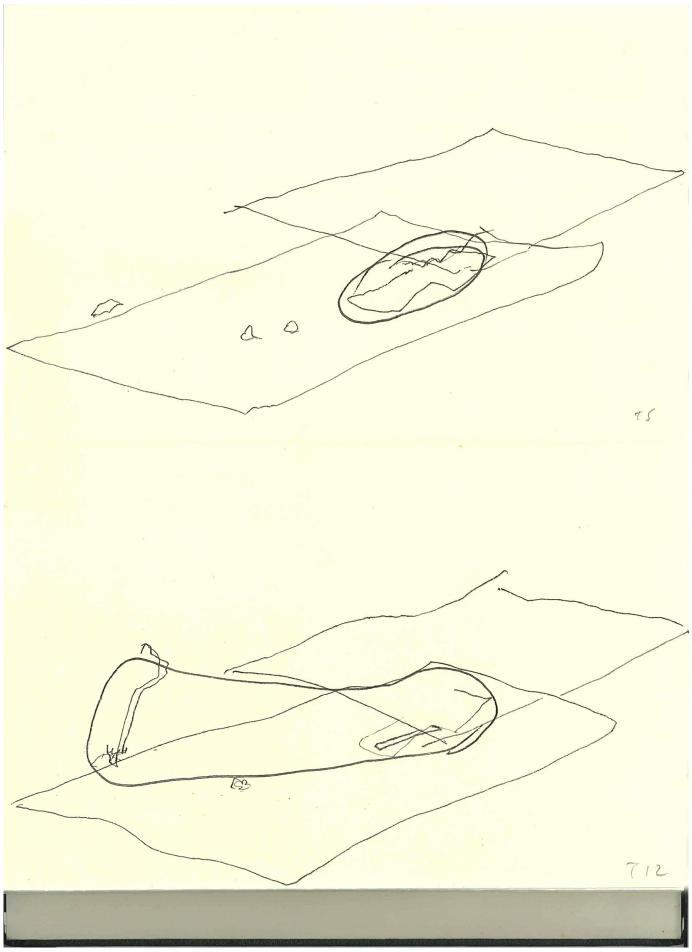


Figure 5.10: Pathways to fields, 3: detail of concertina sketchbook 2, pages 1 and 2.

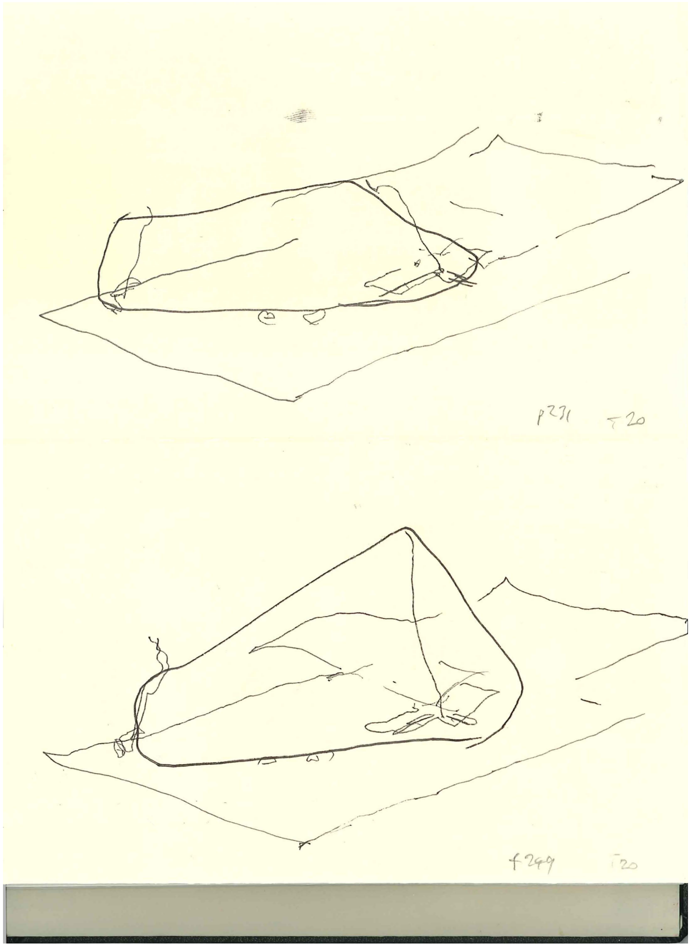


Figure 5.11: Pathways to fields, 4: detail of concertina sketchbook 2, pages 2 and 4.

5.4.2.2 ***Results: Developing upon other theoretical themes***

Representing Gesture-completion by a second person, often with a temporal delay, is a requirement for developing the richness of drawings of human interaction (Sect. 5.1.4). Joint-completion is an addition to the description of 'catchment' given by McNeill. We have seen how a gesture-unit becomes a dyadic (shared) phenomenon, where one person completes another's gesture (Furuyama, 2000, Núñez, 2008, and Yoon et al., 2011, and see Sect. 2.2.9).

An interesting example of gesture completion is found in the Case Study ethnographic data. Architect **D** dwells upon a spot upon the plans, moving his finger along a small axis, while developing a line of thought. Simultaneously, and following on from this, architect **B** picks up on this and completes and then extends it with his own co-speech gesture above the table.

Catchment. In another intriguing instance there is evidence of temporally distributed catchment, upon the theme of open space, described by architect **A** as an 'airscoop.' **D** curtails his gestural contribution to this theme at Turn 25, and at Turn 45, architect **A** carries this theme forwards, from approximately the same place where the other architect's gesture ceased. **A** develops its iconicity spatially (Sect. 3.3, and 3.3.0.4).

This recycling and revamping of a thread of topical iconicity, or catchment, has been recorded in detail by drawing looped lines with differing qualities. **A**'s gesture accompanying Turn 5 (small flourish with the pen as it is lifted off the paper) is drawn as a relatively small irregular triangular shape at low level in the second panel of the series of small multiples; and **A**'s subsequent spatial qualification of Turn 5 is drawn in the final panel as an angled ovoid shape at higher level (Small Multiple 2, Fig. 5.27).

These separate phenomena within the same data clip, are examples of complex shared space, the distribution of catchment across a group, and joint gesture-unit production. These are all represented in a number of the exploratory field inscriptions discussed here. This is achieved by isolating and grouping sets of points so that they may be organised into a particular spatial relationship (Fig. 5.9).

Representing joint phenomena with sparse vectors alone, will not evoke the inhabited physical spaces of the interaction. The preferred solution, in the light of the present criteria, moves beyond the particularities of sparsely represented vectors, towards showing the highly relational qualities of adjacency, intersection, and disposition. Some researchers have isolated paired gesture vectors, made by different people, and have presented them diagrammatically, superimposed over a video still, and distinguishing their contributions as separate referenced entities: one dotted and the other in solid line (Sect. 2.2, Fig. 2.49).

Gesture space and discourse. A drawn outline that identifies the discourse as a whole, enables fields within this to be set up as units of analysis. For example, the architects in their meeting are modulating a single shared field of *joint* space, through their posture, speech, and manual actions upon the smaller sub-spaces. This is not dependent on the extents of physical reach-space, but has has been reached by an understanding of how qualitative space organised into fields.

Application of these methods leads in some circumstances to multiple types of spaces being inscribed simultaneously. Subsets of the data can therefore be combined in unusual ways. The modulation of drawn and gestural spaces on paper (or in the air, as in Turn 20), can be combined with drawings of varying head and hand positions (Small Multiple 5, Fig. 5.30). Inscribed spaces can also be combined with gaze direction and general posture changes (Figs. 5.31, and 5.32).

This type of experimentation is only possible where a careful distinction is made between the varying elements within the data: sparse vectors that relate to movements, clusters of these vectors, and outlined groupings of these clusters, along with selective use of figurative and environmental elements.

5.4.3 Results: Drawings of the context

This section examines the role of human bodies, and also the role of recognisably human artefacts, when constructing speculative representations of human interaction. The latter refers to physical objects (plans and pens for example), gestural objects (constructs of thought, intended projections of information upon the scene), and speech (in the form of transcript information).

*5.4.3.1 **Results: Body and object centred drawings***

For the purposes of this chapter, people have been drawn in a style that is characteristic of the literature, using simple line that has been traced from video frames, and showing relevant objects and context (Fig. 5.12). In addition to this, gesture vectors have been drawn as a ribboned arrow, and a retraction movement is drawn as a series of unlinked arrow heads (although this is not a conventional device). The lines annotated with numbers 21-22 represent the way in which the architects placed their speech Turns within the physical context .

Another representation of the architects shows the same paper plans, with the disposition of their hands at different times (Fig. 5.13). This superimposes 'before and after' hand positions over the paper subspaces (shown respectively on the left and right side of the image). The drawing clearly does not represent the shifts in qualitative space that are being effected at this moment of the interaction, as shown by the transcript. This image would not be able to show these without extensive captioned explanatory text, 'thick description' as this is sometimes called in ethnographic studies (Marchand, 2010).

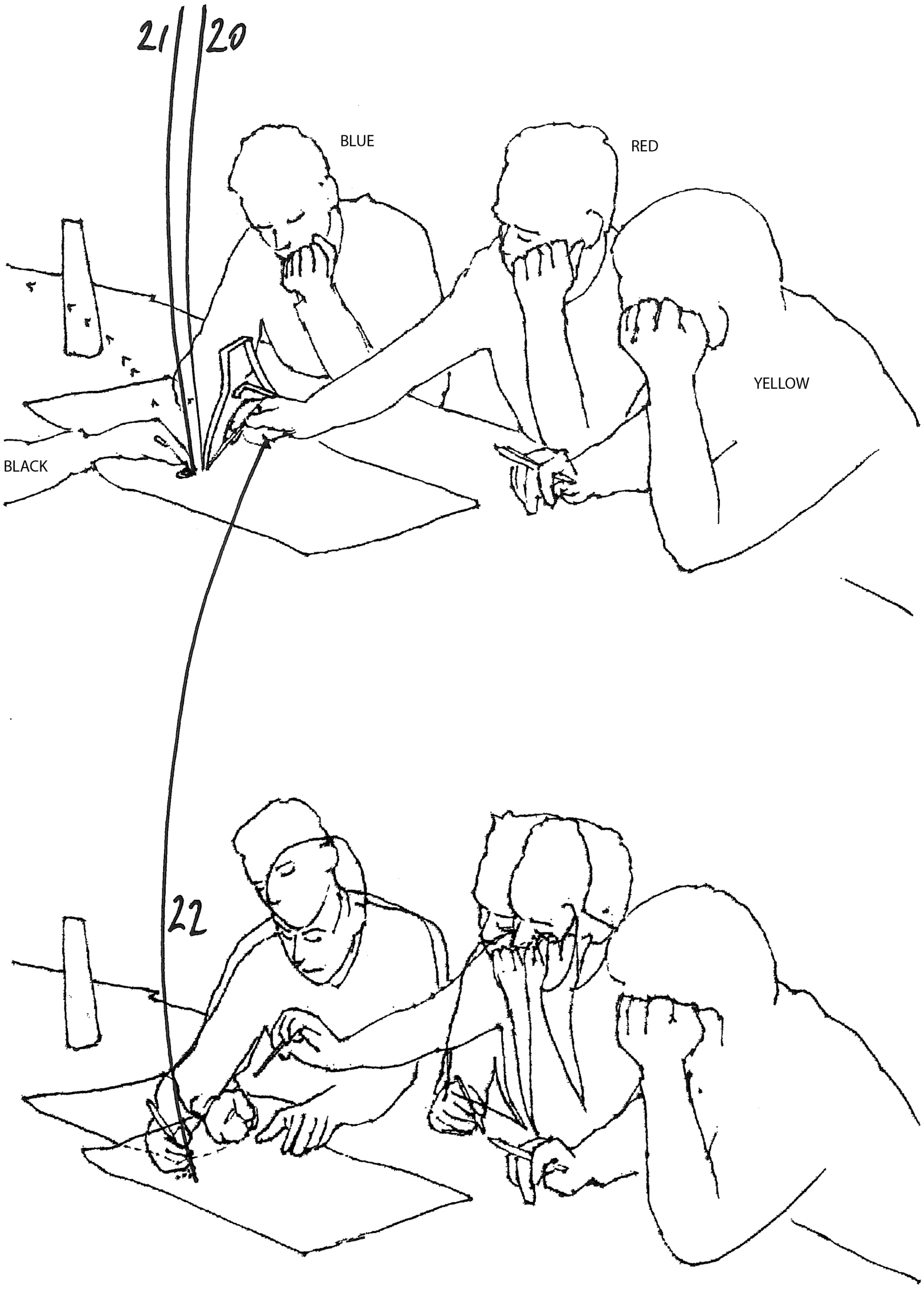


Figure 5.12: Small-multiple: paired line drawings of Turns 20 and 22.

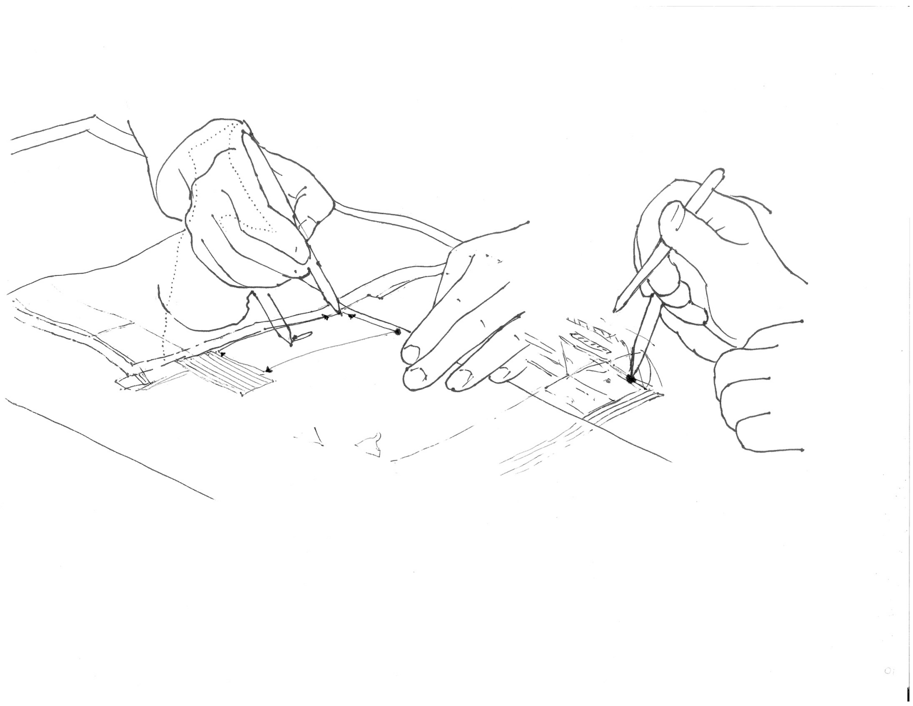


Figure 5.13: A closer view of hands (architect **A** on left and **B** on right) Based upon telescopically zoomed shots contained in the video.

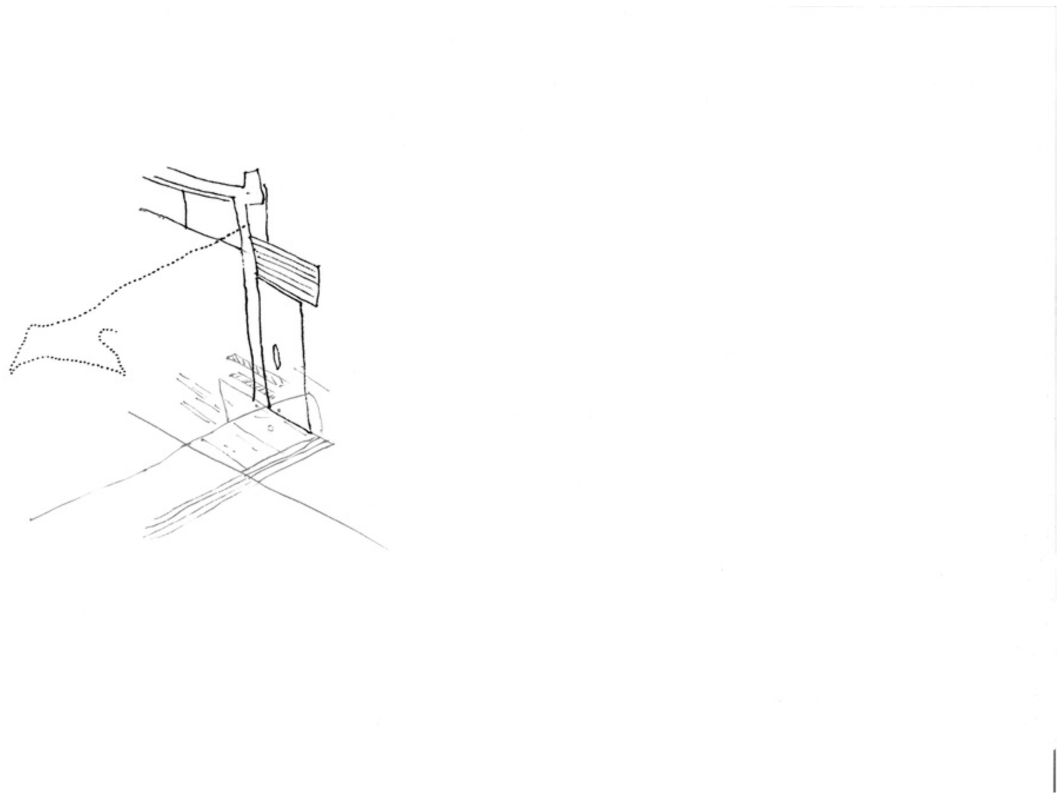


Figure 5.14: A qualitative space is drawn by superimposing drawings at right angles to each other. The secondary paper drawing (and its attached gesture vector) stands orthogonally to the primary horizontal paper drawing, suggesting the gestural object created by **B**.

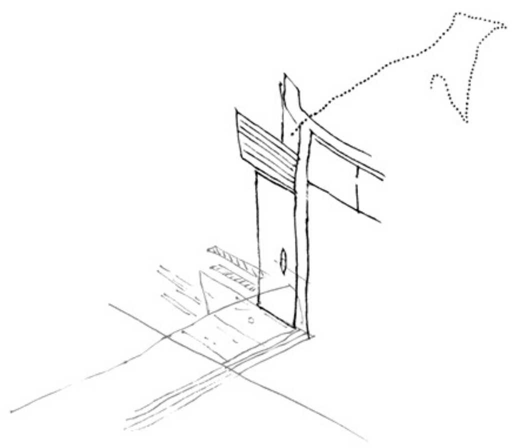


Figure 5.15: Drawing informed by multi-dimensional drawings: another spatial interpretation of the gestural object, on this occasion rotated over the plans to show another viable orientation.

5.4.3.2 ***Results: Multidimensional haptic reconstructions of the data***

The gesture space schemas of McNeill and Kendon lend themselves to speculative visual experimentation by virtue of being highly graphic in their conception and expression, and by their concern with body-centred representation (Sect. 2.1). The drawing studies shown here that are based upon these schemas, attempt to recast and recombine certain concrete aspects of these theoretical models, and to visualise this as applied to the data excerpt being studied here. This makes their spatial implications visible, unavoidably raising questions about such schema in the process. This work was aimed at the requirement for the articulation of the *o-space* (Sect. 5.1.2).

Extensive visualisations of the theoretical models of gesture space were carried out by modelling them with a bespoke haptic digital drawing system, *Cloud 9* (Dima et al., 2009). A variety of haptic and other multi-dimensional drawing systems are in existence (Willis et al., 2010). This explores the question of whether digital tools can usefully apply an 'expanded' concept of drawing, that is, non-traditional means and unconventional methods of display (Sect. 1.7).

On the one hand, drawing from video, and on the other, multi-dimensional digital modelling that reconstructs interaction based upon video data, are not so different from each other, and could complement other more traditional techniques, such as drawing from 'life' in field research.

The same 'cohesive chain' that was initially tracked through the data by drawing on acetates placed over screens for example, is now re-drawn in multi-dimensional space. The resulting drawings (in the expanded sense of the word) place the semi-abstract digital versions of Kendon's 'transactional segments' into virtual space (Sect. 2.1). These were then merged into a series of overlapping gesture spaces that reflect the changes in body positions (Fig. 5.21). The results bear a resemblance to Bacon's model of rhetorical gesture space from 1872 (Fig. 2.2). The details of the criteria that were used to design these models, and other views of the resulting works, are set out in more detail elsewhere (Appendix. E).

To begin with, the physical context of the excerpt was modelled in *Cloud 9*. These were recreated on a 1:1 scale within the virtual scene. Paper sheets lying on the table, and pens, were modelled to scale, and actual dimensions could be safely estimated for these and placed in relation to hands and forearms of an estimated average size. The upper limbs of the four architects were modelled using open source 3d models, adjusted to match the disposition and posture of the original filmed hands. Positional changes for each of the seven visuo-spatial segments of catchment were drawn out using the *Cloud 9* drawing tool. They were later merged into one larger model representing the usage of space over a period of time (Fig. 5.24). The effect can be compared to drawn comic art, apart from the intersecting of these three-dimensional volumes (Fig. 4.11).

By virtue of this merging of increments, time was encoded within this 'mass' of digitally inscribed bodily space. This revealed the shared gesture spaces that are made apparent through the usage of space rather than as a result of applying body-centric concepts such as Kendon's 'transactional segment', Fricke's 'origo', and McNiell's loci of gesture space, the *manubrium*.

The last of the series of digital works attempted to pursue the body centric criteria for qualitative space to their logical conclusions, by editing out of the model as many of the unnecessary parts of the model as possible, leaving only those parts that could be said to relate to space inflected by qualities of interaction. Parts of hands, fingers, and pens, of the four architects, were excerpted from each visuo-spatial contribution to the chain of cohesive catchments, and then collaged into one multi-dimensional view (Fig. 5.25).

At the beginning of this chapter a contrast was drawn between hand-made drawings, and representations made with the aid of digital technologies such as motion capture (Fig.5.3). The modelling of the excerpt using the haptic drawing system *Cloud 9* is supported by technology, but is also dependent on the operator's interests and manual skills, as expressed in the management and approach to the task. This technique is work-intensive and unlikely to be widely adopted. However, the use of digital tools such as this to organise qualitative space, is a valuable exercise in speculative drawn visualisation. One development that this points towards is the modelling of shared spaces that are not dependent on body-centric criteria (Sect. **??**).

This digital drawing process was the basis for line re-drawings made by tracing from screen captures of the digital work, and were made for publication purposes (Heath and Healey, 2011, Figs. 5.21, 5.22, E.4).

The conclusion derived from this series of digital studies was that the physical objects modelled with them, could be the starting point for a broader investigation of how to construct qualitative spaces from the physical spaces. This led to testing of possible cues in the position of resting hands, and the spaces between them. The detection of the cues can be refined iteratively. For example, it was possible to use the surface of the table as a base for qualitative 'volumes.' These were built up from from the topical spaces being jointly constructed on the table top. They were given further dimensions by looking for interactional cues to act as construction points (and lines) in the space around and above the table top.

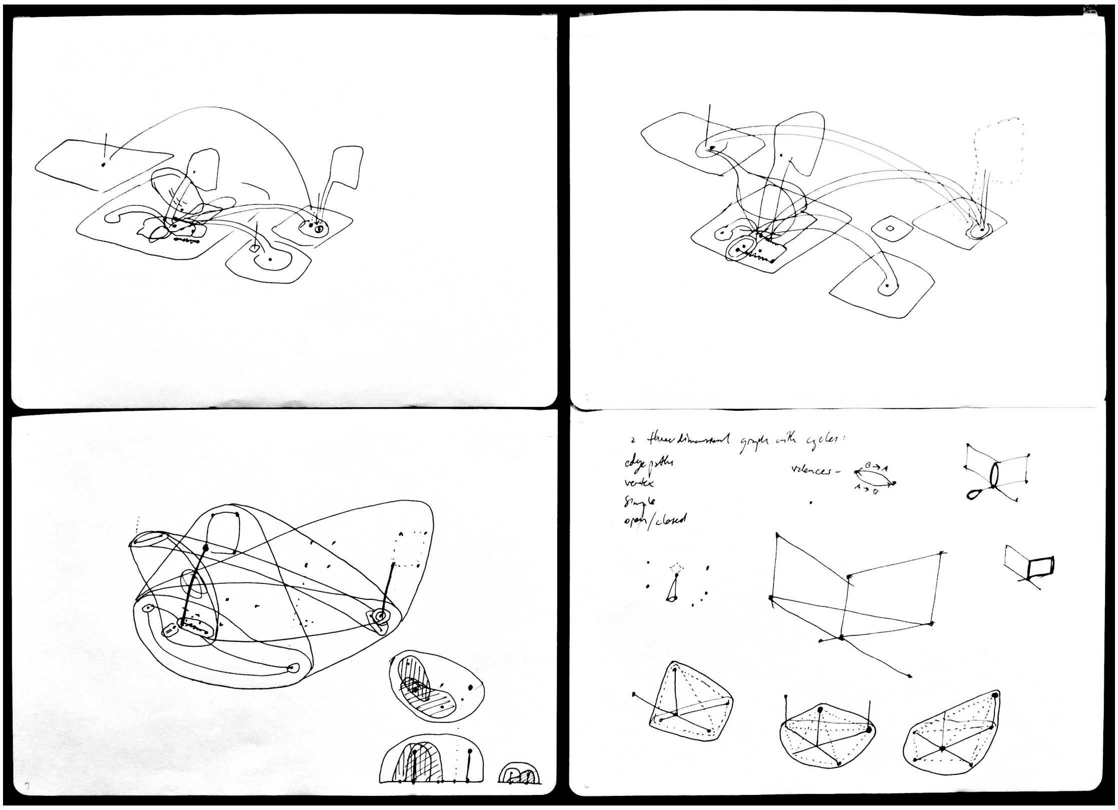


Figure 5.16: Sketches of the topological relationships amongst the speech-turns.

5.4.3.3 ***Results: Paper drawings informed by multi-dimensionality***

Drawings following these digital studies did not rely so strongly upon cues based upon reference points of individual bodies, or metric space, for example (Sect. 5.3.2). A significant subset of drawing studies were aimed at testing assumptions of body-centric visualisation of interaction, as had been found in the literature (Sect. 2.1). The precise criteria used for this multi-dimensional modelling of gesture space intersections, and were presented at the *Gesture Workshop* in 2010 (Heath and Healey, 2011).

The initial steps taken towards this non-metric characterisation of interaction, were stimulated by drawings that undertook a partial abstraction away from the physical surroundings. These represent the topological features of the subspaces, those that are not dependent on metrics but on relations (Fig. 5.16). These diagrams and sketches were not as tightly tethered to the video frames and physical spaces as other studies. This loosely topological view of the spaces, expresses relational values that can be tagged to the details of the interaction. The physical arrangements in the data would later lend their qualities to the refinement of these studies into a more varied form that contained both relational information, and specific details of interactions.

Multi-dimensional sketching informed subsequent ink on paper drawings. These digital tests remade the floor plans and elevations that lay upon on the architect's table, as entities in dimensional relationship. These ostensibly flat 'drawn' shapes were drawn in 3d in order to allow the side-view (elevation) of the design proposal to be inserted into the top-view plans of the design. This graphically conveys the intention of the architect in question. However, there remains the question of which orientation this insertion should assume. Two alternative 'readings' of the orientation were devised, combining the input from the 3d study with the plans and figures in the extract (Fig. 5.14, and 5.15). The dotted line represents the gesture path of Turn 20, carving out a space for the 'opening above the door.'

Placing this dotted gesture pathway on a vertical axis locates the position of this opening more exactly, and in an approximate way that is suited to the rapidity of gestural interaction. This gives another, alternative reading of the gesture and speech. The rotation of this part of the topical space would not have been possible if it were not for the 3d studies that suggested it. The preference for one reading of the orientation over another is immaterial (although it would seem that Fig. 5.14 is well aligned with the extract). What is of greater interest is that this method of triangulating between results in different representational mediums is able to provide us with a detailed readjustment of the spaces of the interaction, and could do so in other circumstances.

Dotted lines were also used in digital drawings to delineate the edges of gesture space (Fig. 5.23). However, the complexity of the results was difficult to read for some, and are confused with dotted motion-lines. The clearest points in these representations are of their intersection with the plane of the table. Hand drawn line is able to reduce this to an optimal degree (Figs. 5.21, and 5.22).

5.4.3.4 ***Results: Anchoring and transcripts***

Conjectural drawing operations require factual augmentation with information from recorded speech gathered ethnographically. To achieve this, information from dialogue transcripts can be added to drawings, anchoring them in agreements reached during interaction (3.2.1.1). The physical environment is also frequently referenced in this speech, and transcripts have an important if not essential role in linking a drawn space to an utterance referring to it.

As an example of how speech can be incorporated into drawings of interaction, the open source tool *GraphViz* was used to align each deictic utterance with specific physical subspaces. The entire clip can be mapped onto a listing of these spaces (Fig. 5.17). Such a mapping is purely text-driven, and shows the extreme complexity that such approaches can result in, and also reminds us that representing interactional topology is a ‘wicked’ design problem (Rittel and Webber, 1973). Alternatively, speech could be mapped onto figurative space, captioning the separate images (Fig. 5.5.1.1).

A novel way of combining visual and textual information is to run them alongside, so that they augment one another. This might involve placing a cascading graph of speech-turns next to a concertina sketchbook filled with drawings of the evolving fields of shared space (Fig. 5.18). As a hypothetical arrangement, the graph on the right concerns the speech, including how parts of it are related to a series of subspaces (‘ss’), and could easily be replaced by quoting the full speech turns. On the left is the entirety of the second concertina sketchbook that has been detailed previously (Fig. 5.10, and 5.11). The combination of textual references to speech and hand-drawn field inscriptions, is an improvement on purely text-based mapping, allowing readers to see the shapes of the spaces that are referred to by the utterances. However, the pairing of drawing and graph shown here would require further clues as to how to connect the relevant parts of each together.

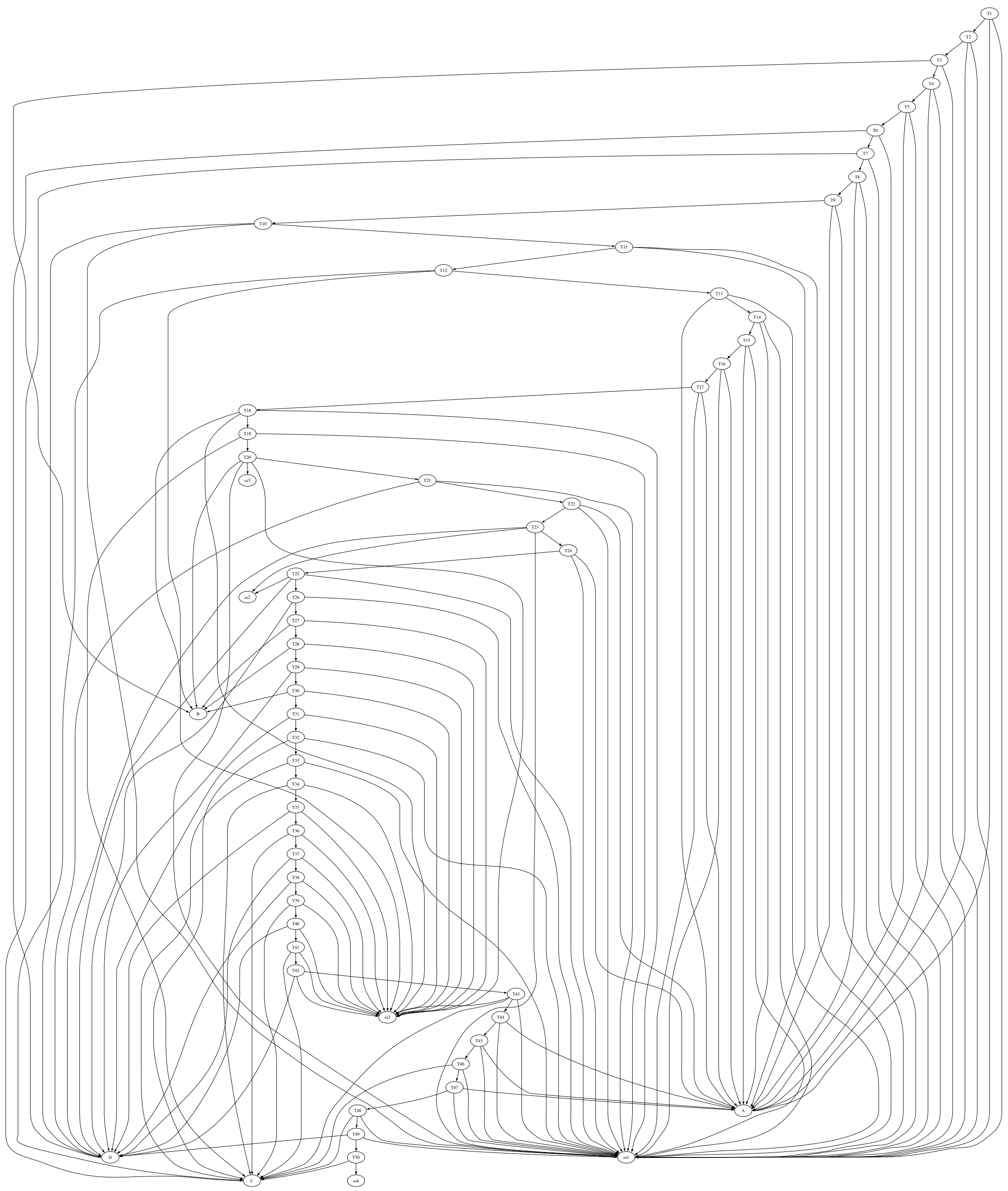


Figure 5.17: Graphing speech Turns 1-50: a cascade of speech turns and their associated spaces, made with *GraphViz*.

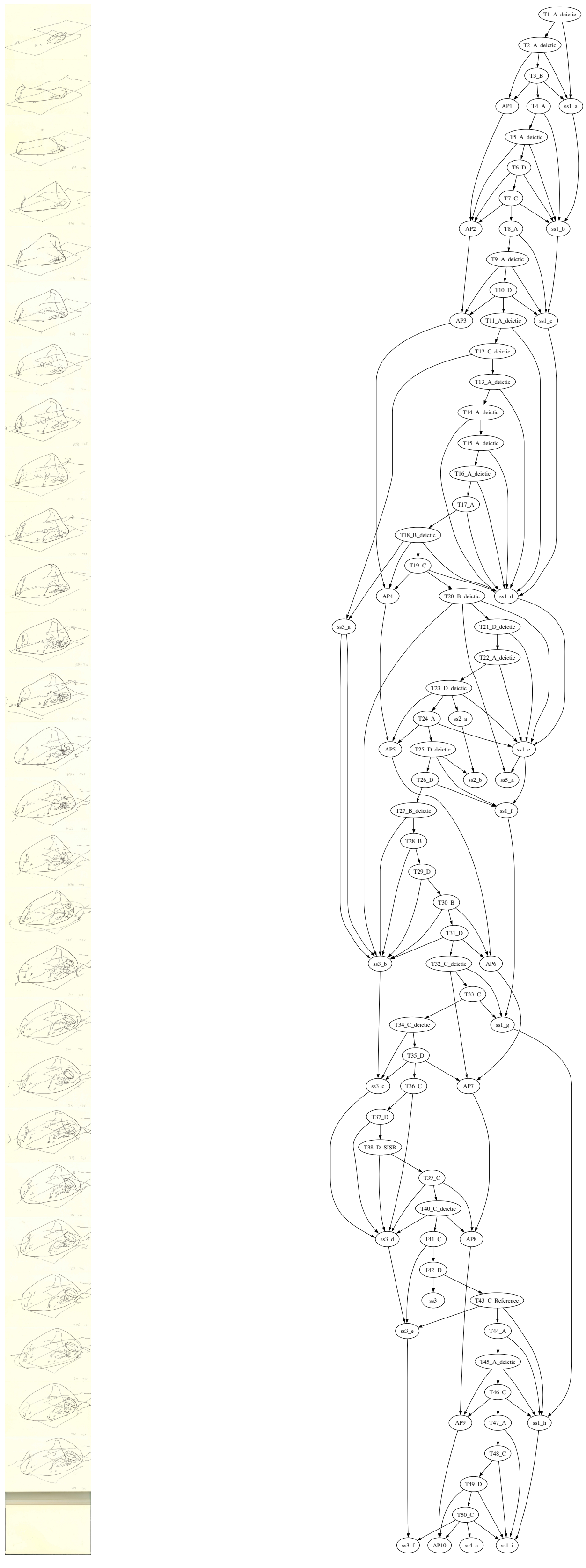


Figure 5.18: Graph of speech-turns, adjacent to concertina sketchbook of drawings of the evolving shared spaces.

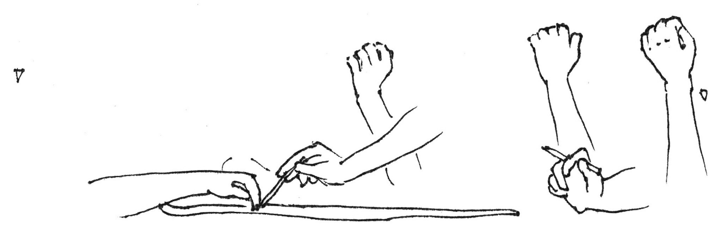


Figure 5.19: T18 to 20 side view. line drawings, informed by multi-dimensional drawings.

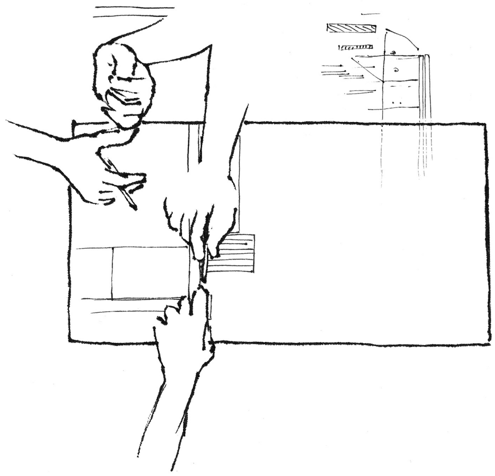


Figure 5.20: Overhead view of subspaces 1 and 3, informed by multi-dimensional drawings.

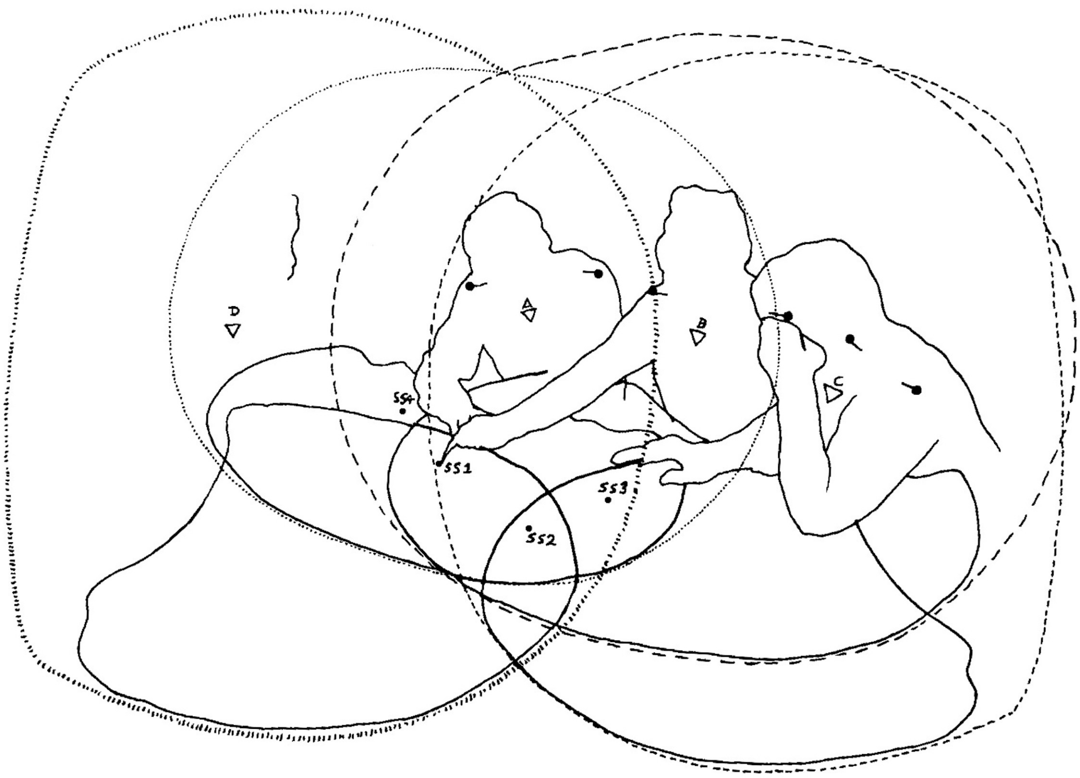


Figure 5.21: Theoretically-based gesture spaces, modelled in *Cloud 9* and applied to the excerpt at Turn 20. This was subsequently replaced by non-metric and non-body centric approaches.

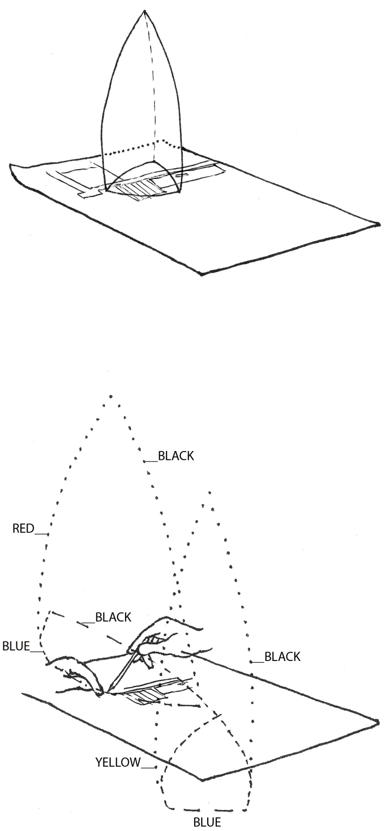


Figure 5.22: The gesture space modelling produces representations of carved portions of shared space.

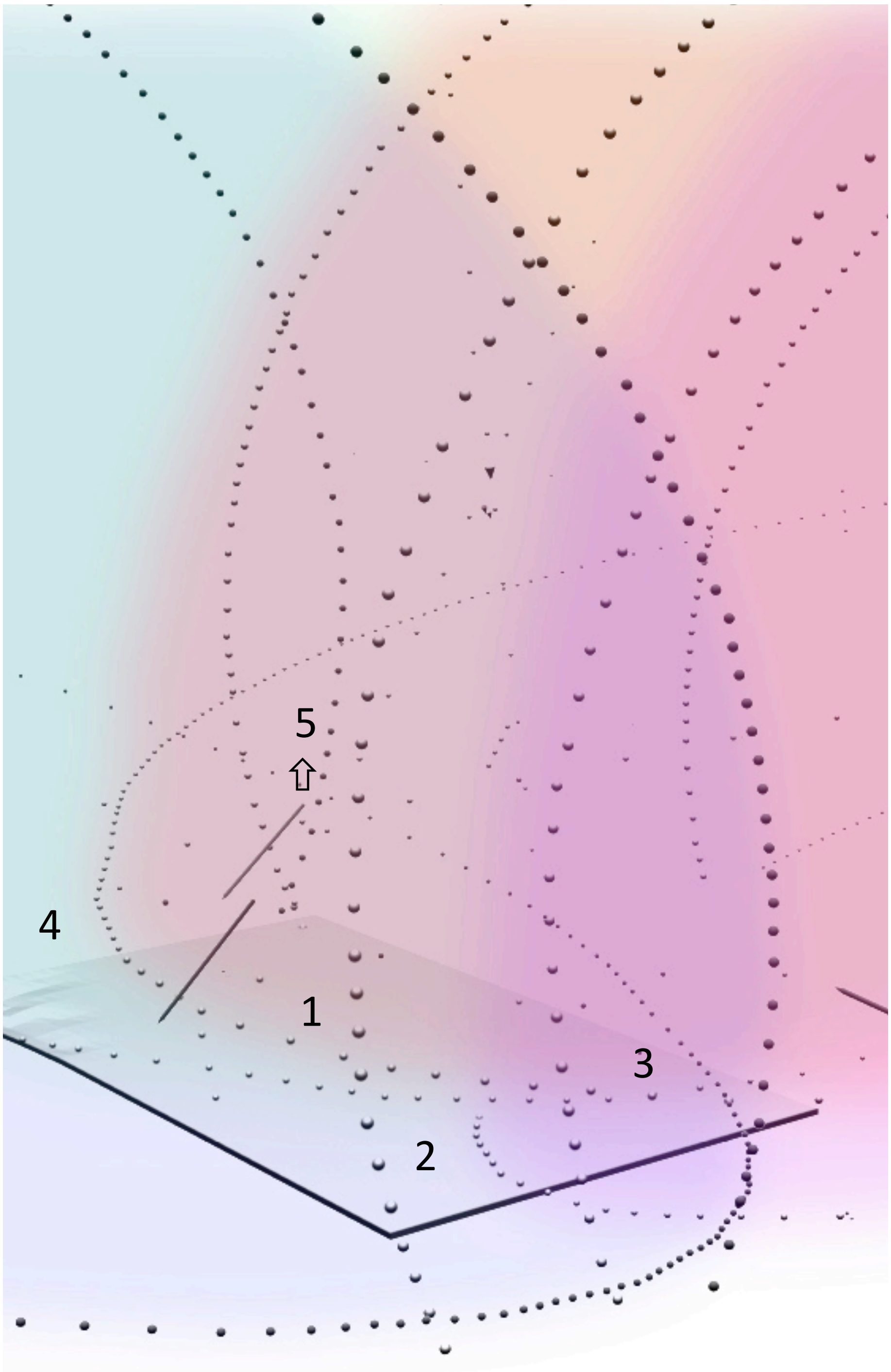


Figure 5.23: Gesture space models for colour-coded individuals. These overlap with one another to produce zones that are particularly shaped and that relate to their reach space and body position at that time.

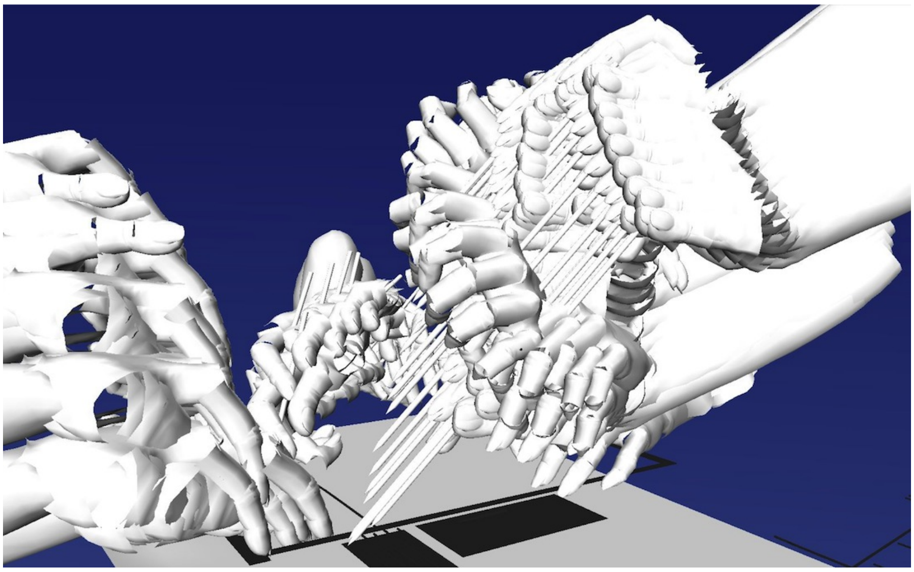


Figure 5.24: The physical and gestural context of the excerpt, modelled in *Cloud 9*.

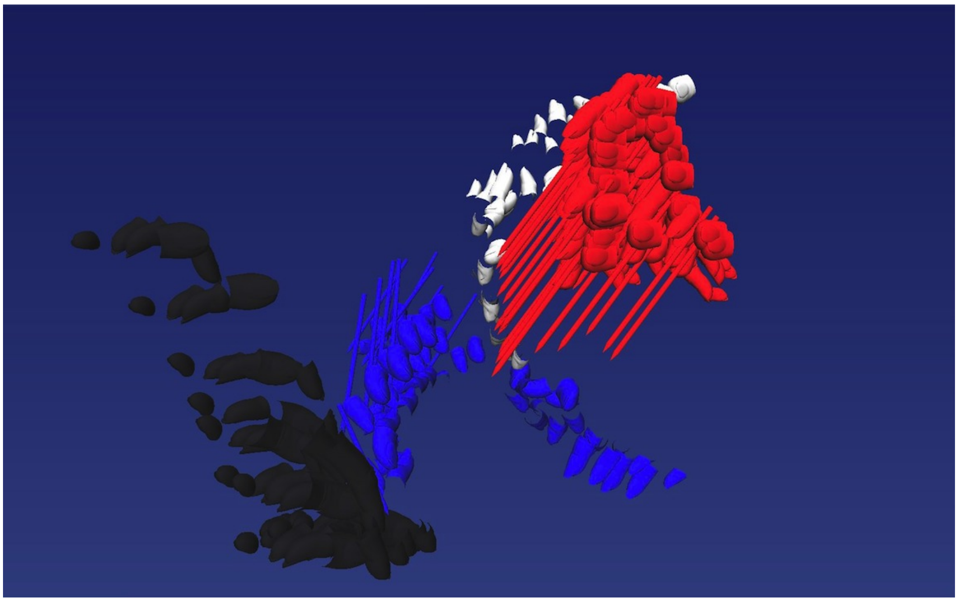


Figure 5.25: Interactional spaces, modelled in *Cloud 9*.

5.5 Conclusions

These insights into new methods for organising space have been developed through a close study of the visual data, and have involved extensive iterations over a long period of time, testing assumptions and results on each pass. The methods described have therefore been devised through parallel manual and conceptual investigations. However, the resulting techniques were designed to be put to quick use, and not to place great demand on the resources of potential users by requiring extensive micro-analysis of video over a long periods of time. In order to be repeatable, a semi-methodical approach to these exploratory drawing procedures is adopted, so that the rationale and its methodology is recoverable by other researchers. Repeatable methods are also essential for the future design of extensions to this research.

The ability to flexibly deploy various combinations of lines and looped outlines is also an important technique in its own right. This flexibility allows a participatory element to be introduced into future work, extending the present research outcomes. Presented with a set of techniques for visually exploring this problem space, there are any number of ways in which further collaborative and participatory workshops can implement these ideas, perhaps in ways that are unforeseen at the time of writing, and responding to the interests and requirements of the research community. This has been beyond the scope of the present work but remains an area of real potential (Sect. 7.2.1).

In the interests of reaching conclusions for this chapter, the drawing techniques need to be somewhat artificially separated out so that they may be compared with one another. The results for each of the facets of the drawing methods are shown in stages, in this section below, in the form of a series of small multiples. Each of these multiples reflects successive stages of the application of the methods, as they have been understood in retrospect. The order of presentation of the drawing tasks, is the same as in the above sections on Requirements and Methods (Sect. 5.1, and 5.3). This structure is also reflected in the ordering of the tasks for the subsequent participatory drawing workshops (Chap. 6).

The continuity running between the small multiple series allows for direct and meaningful comparisons to be made amongst the drawing results. This strategy has been used elsewhere to map out the cognitive differences between the drawings of different individuals, and also to break down a drawing task into its constituent cognitive stages of development (Van Sommers, 1984).

5.5.1 A progression of small multiples

Having seen the enrichment provided by inscribing the qualitative fields within the interaction, we can reverse the question which we started from. Rather than ask whether simple vectors can be expanded into larger spaces, we can assert that without these larger inscriptions, pathways make little sense when they are amassed.

The starting research question was whether gesture pathways could be enlarged into forms of shared gesture space, and a view was reached that simple vectors can be interpreted as collapsed 'minimal' versions of these larger surrounding spaces, those that are intangible but whose presence is distinctly felt (at the very centre of all of the 'onion' layers, so to speak, while other spaces are altered around these).

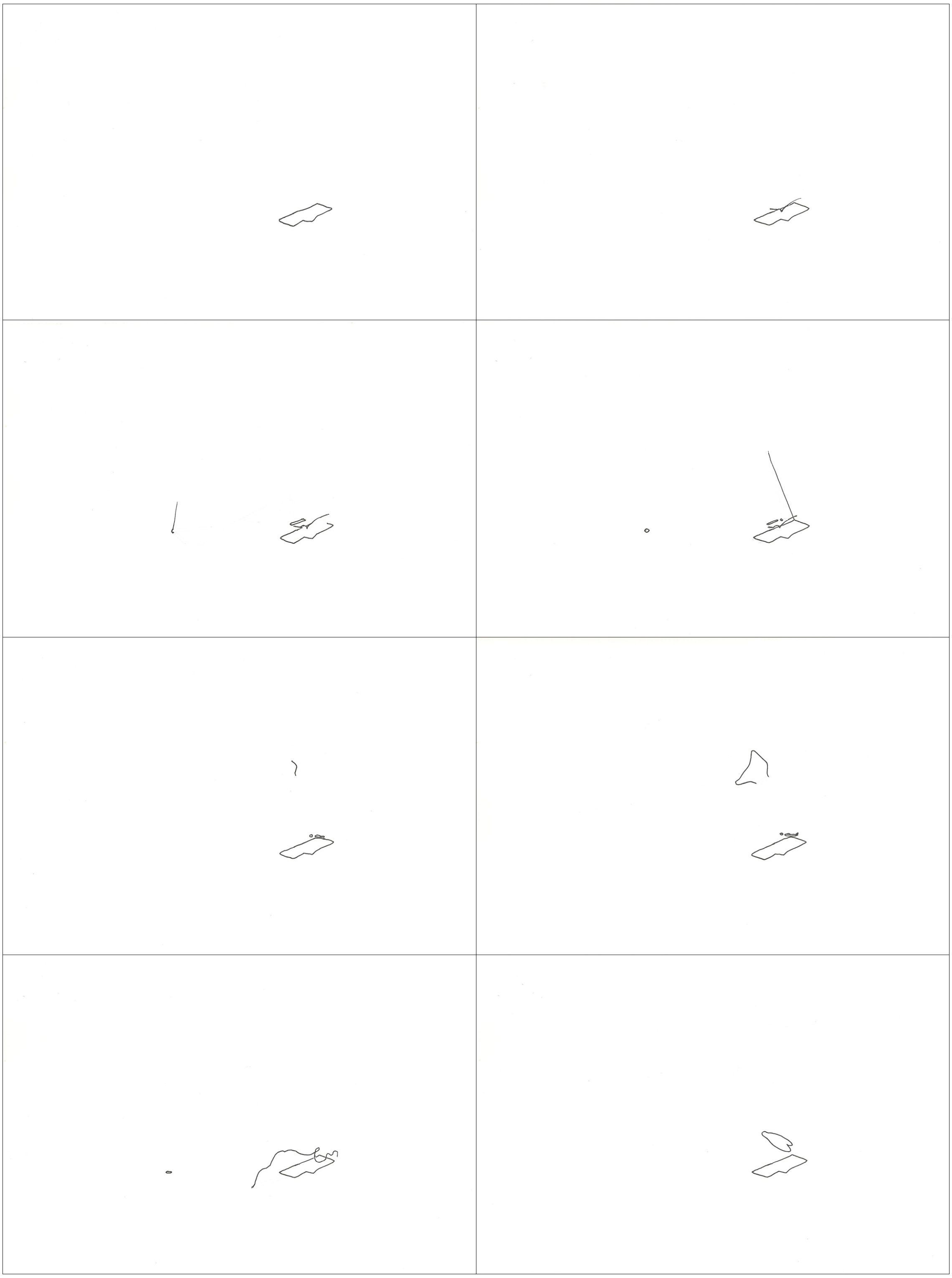


Figure 5.26: Small Multiple 1: composite view of the gesture-path vectors from Clip 1. These relate to the series of visuo-spatial *catchment*. All of the subsequent composite views build upon this framework of vectors.

The first small multiple sets out basic building blocks of qualitative space, the vectors associated with specific contributions to dialogue (Fig. 5.26).

5.5.1.1 ***Gesture extension***

The second of the small multiples develops upon the first by inscribing a shape that expresses the fact that the preparatory phase of B's aerial gesture is intrinsically linked to D's contribution, so much so that this can be called an example of gesture completion (Fig. 5.27). The fourth panel contains a sharply-pointed triangular shape, the base of which is constructed from the point of B's pen before it takes off, and the movement of D's fingertip nearby, referring to the same spot on the architectural plans. The triangle-like shape therefore shows the union of the spaces that are created by this phenomena. By implication, it also shows shared space. Once this analytic step is taken all sorts of new possibilities arise. The drawn and visual component of this step is not just supportive or illustrating, but is responsible for it.

This addresses a number of requirement points, concerning the articulation of the o-space, and gesture completion (Sects. 5.1.2, and 5.1.4). The small multiple is designed to point the reader towards a specific way to encapsulate a qualitative space. It is not intended to be a fine-grained representation of gestural 'embroidery', or to convey physical momentum. The latter goal would be accomplished by adopting drawing strategies found in the literature: arrowing, and layering of arm movement for example (Appendix D. Section 15, Movement: ribboned arrows; Section 20, Movement: fine forward differencing). These strategies could also be easily integrated with field inscriptions.

The other panels in this multiple also make their separateness apparent, by being linked together. An interpretation of the spatial relationships is seen in the obvious intersections and adjacencies between them. Occlusion of one looped shape by another is a technique that is used to suggest this interplay of spaces.

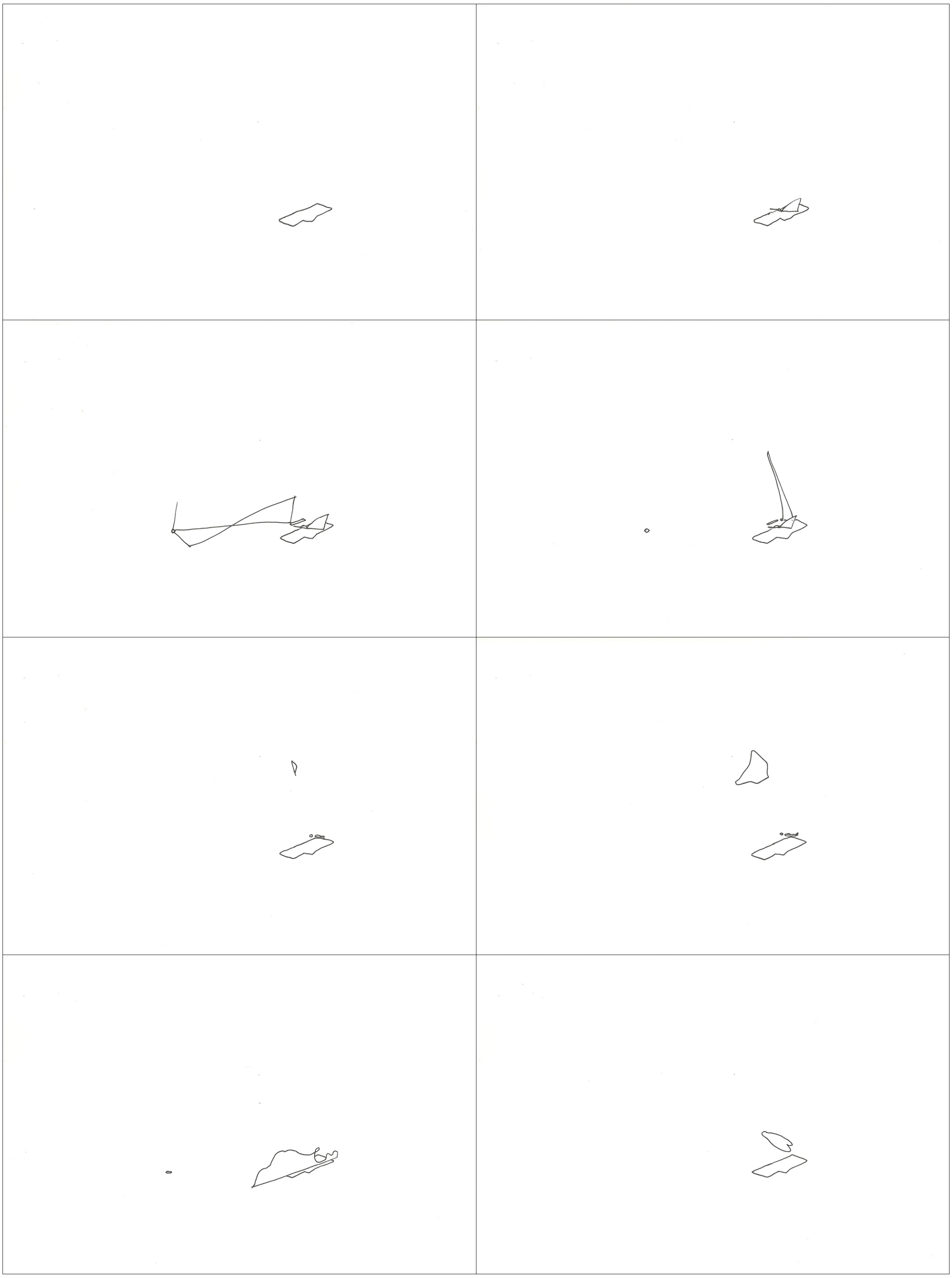


Figure 5.27: Small Multiple 2: composite view of the assembled pathways described as self-enclosed (or 'looped') vectors.

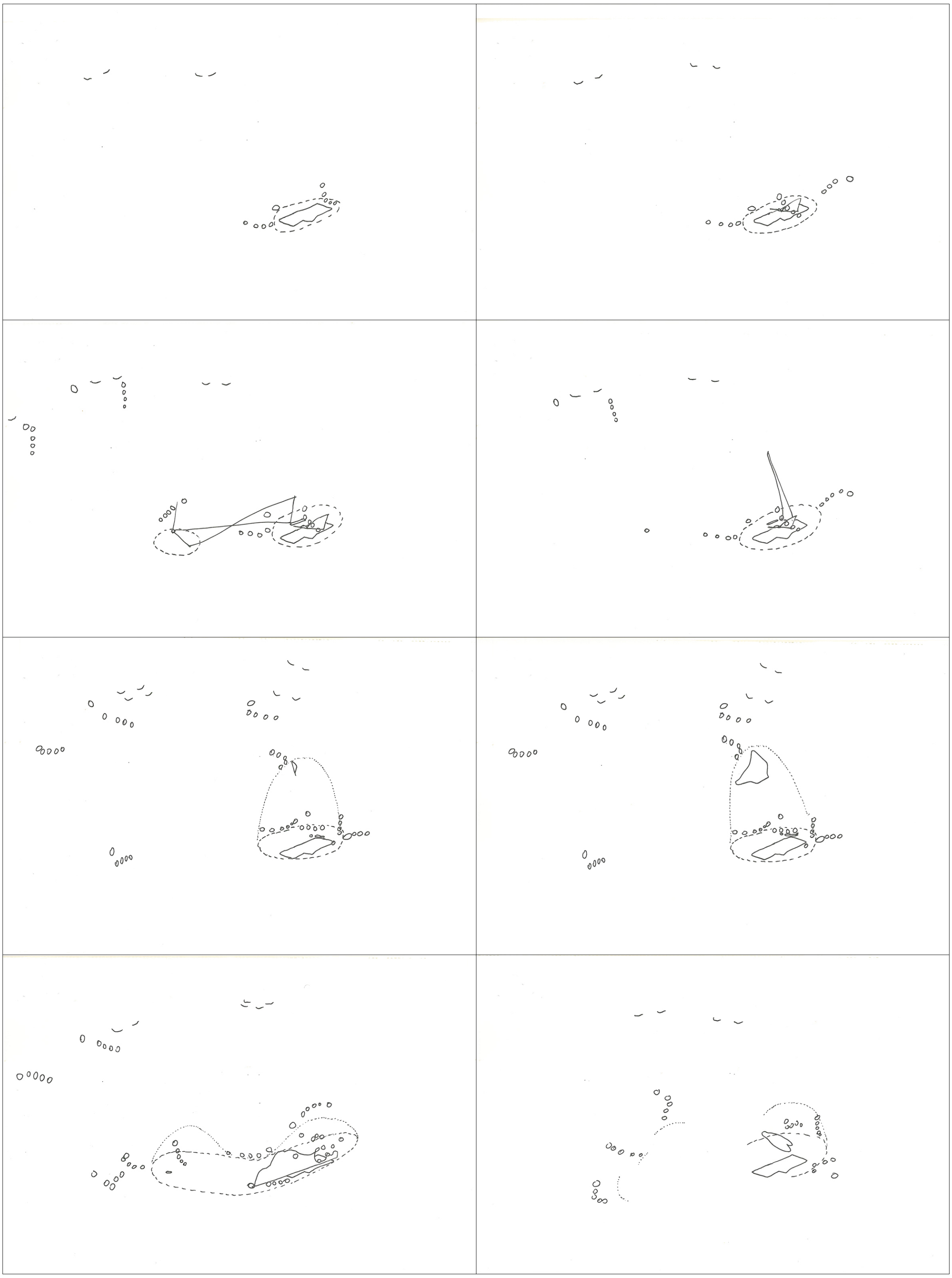


Figure 5.28: Small Multiple 3: field inscriptions in solid-line are grouped by dotted line. Also represented are the position of the participant's eyes plus their fingertips and thumbs.

The apparent opacity and transparency of inscriptions can be suggested by a mix of graphic techniques. Small sub-spaces are given field inscriptions in solid-line, which are are then grouped by a surrounding dotted line (Small Multiple 3, Fig. 5.28). The broken line lies flat on the table to begin with, but as gestural Turns become increasingly spatial, these dotted outlines rise up, becoming contoured dimensional volumes. Also represented are the positions of the participant's downcast eyes, plus their fingertips and thumbs as peripheral framing phenomena.

The disposition of resting hands was of particular interest in regard to their role in the interactional framing of shared spaces (the dotted zones). The first panel in Small Multiple 3 shows this: the rectangular shape is what is drawn on the paper, the fingertips are used to infer and construct a flat dotted zone around this. Further along, the arrangement becomes more complex as gestures employ the space above the table. The hands of the participants frame the spaces, and this drawing method assists us to see the way in which empty space is used to accomplish this effect. This addresses the requirement for visualising the finer structure within the o-space (Sect. 5.1.2), and also for ascertaining the role of boundary phenomena (Sect. 5.1.5), and finds a use for the negative space drawing technique (Sect. 5.3.2.2). It also relates to the theoretical drive to characterise the space to which all members of the group have access, using a visual format that is accessible, topographical, and not diagrammatically abstracted (Sect. 2.3.2).

It is possible to construct a composite of finer and coarser grained interpretations of qualitative spaces found at each speech Turn (Small Multiple 4, Fig. 5.29). This demonstrates how these drawing methods can accommodate differing modes of field inscription, sometimes within a single image. This capacity relates to a range of theoretical requirements that have been identified in the survey of the literature (Sect. 2.3.2). These include the ability to map rapid shifts in indexicality with fields that switch between poles, indicating the plasticity of referenced spaces and meanings. This is seen by comparing a number of the panels of these multiples. Non-contiguous interactional spaces would ordinarily defy visual representation, but this problem

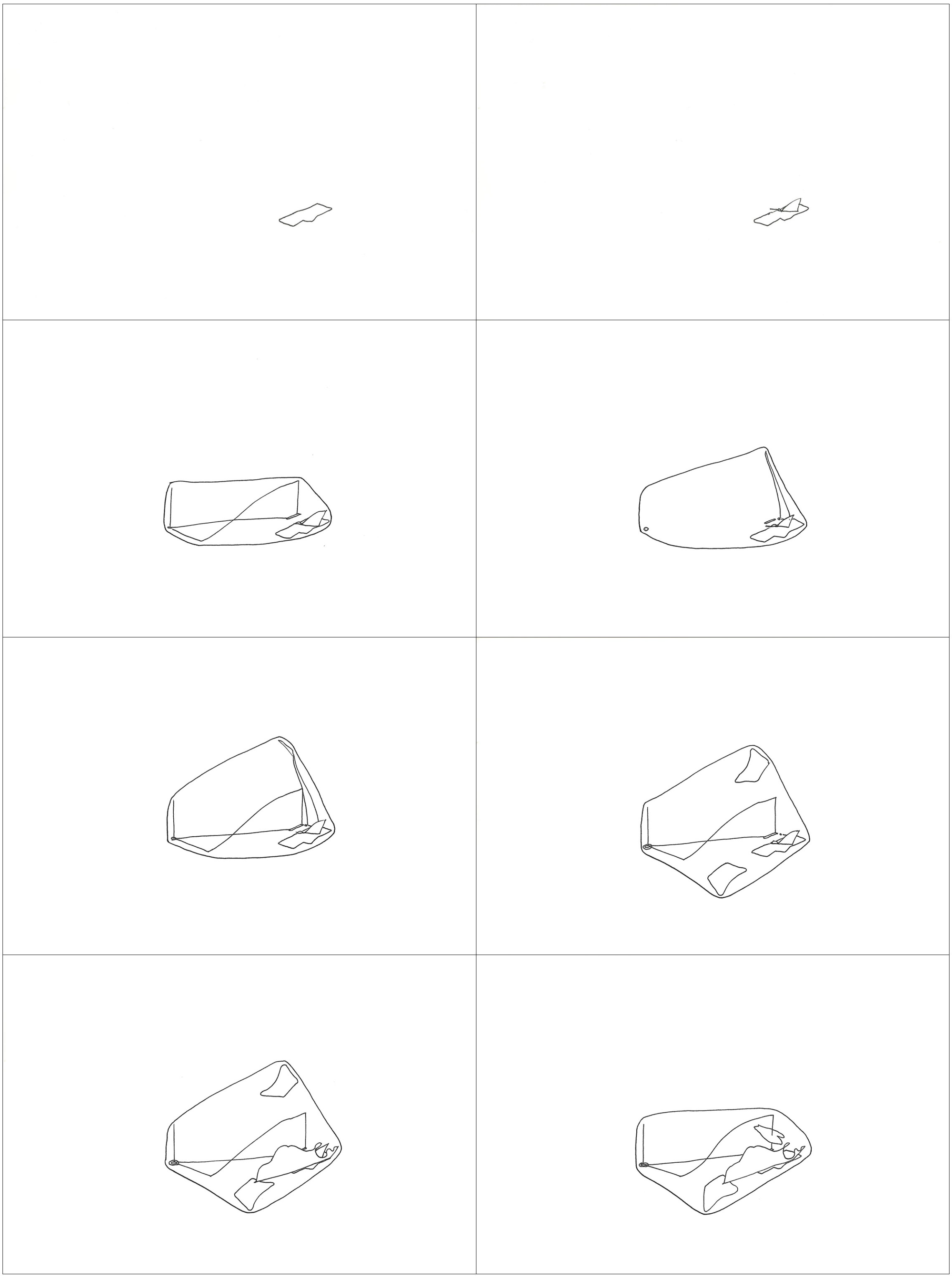


Figure 5.29: Small Multiple 4: composite of finer and coarser grained interpretations of qualitative spaces at each Turn.

can be addressed by combining the drawing techniques in such a way that it is clear that the vectors and fields do not map smoothy onto regular environmental spaces (for example if Figs. 5.14 and 5.15 were combined into one image, or a pair where neither was preferenced).

Furthermore, the later panels in all of the small multiples demonstrate the layered and interwoven nature of the contributions that are nested within the environment of the interaction. This satisfies the theoretical requirement for visualisation, that has been expressed as a need for a more topographical approach to understanding and visualising interactions (Rodrigues, 2010).

The addition of another layer of information into the representation, tests whether these field inscriptions are able to be integrated with the physical setting. Downcast eyes for each architect are drawn, and the location of the tips of their fingers and thumbs (Small Multiple 5, Fig.5.30). This addresses requirements concerning gaze pattern and boundary phenomena from previous chapters (Sect. 5.1.6, and 5.1.5). The results give an impression of joint focus of attention in specific areas in front of the figures, and the differing shapes of the fields implies that there is an interactional process unfolding from frame to frame. There is also a clear differentiation between these shapes, some possessing very particular outlines that could only be the results of human action (rectangles drawn on the paper, for example), while others around these have rounded corners and softer edges.

When a visual method for the construction of shared space is applied consistently to an excerpt of data, it unifies various threads of analysis into one view (Integration study 3, Fig. 5.33). This view is necessarily incomplete, and purposely exploratory, and this mode of representation is designed to be a provocation towards further development and opportunities.

It is worth comparing the initial 'time-worm' representation of the data extract (Fig. 5.5.1.1) with the later experimentation with a small multiple drawn onto a segment of scroll (Fig. 5.33,

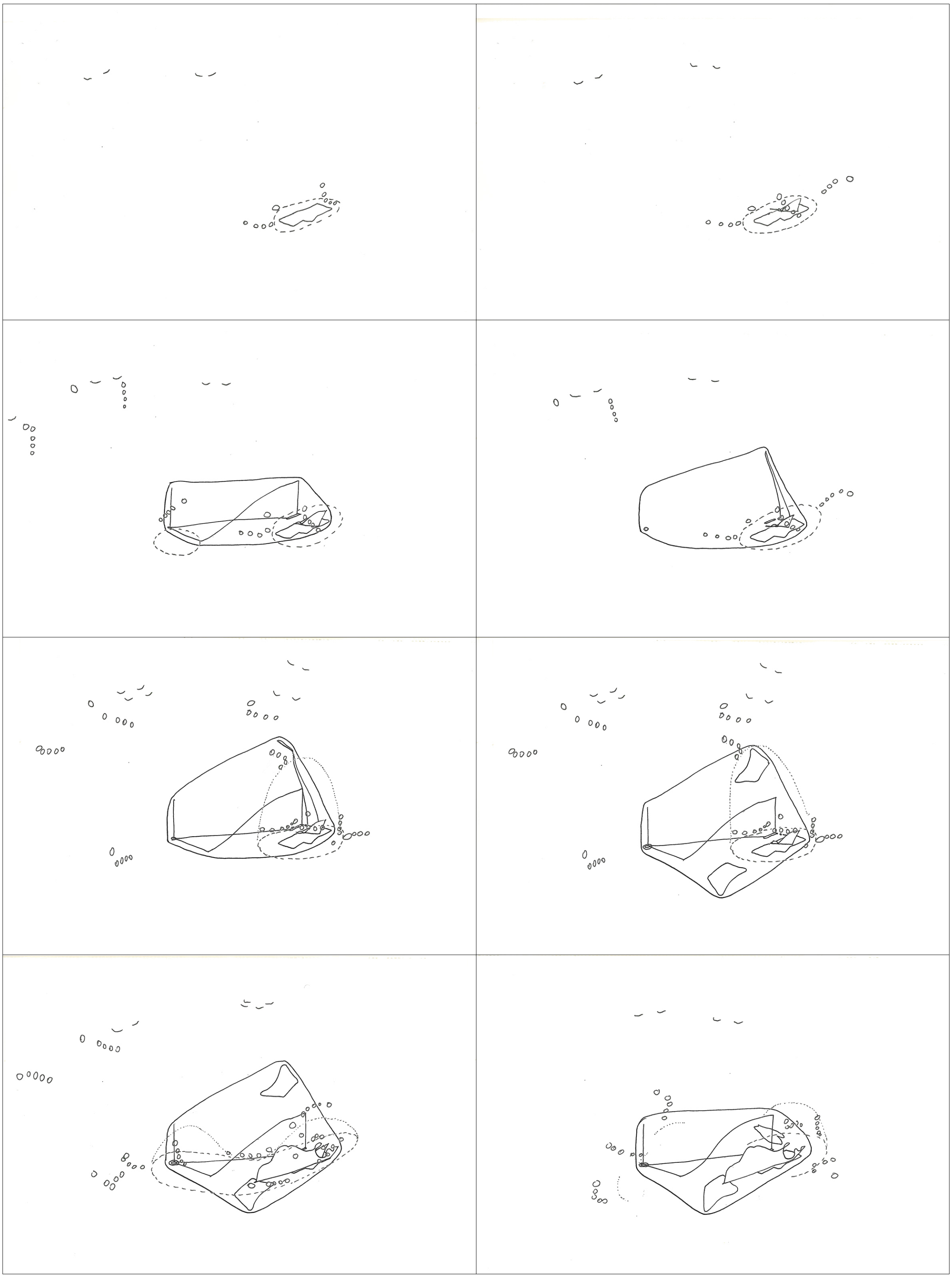


Figure 5.30: Small Multiple 5: composite of field inscriptions plus single fingertips, thumbs, and eyes. Dotted lines refer to alternate interpretations for the placement of some of these fields.

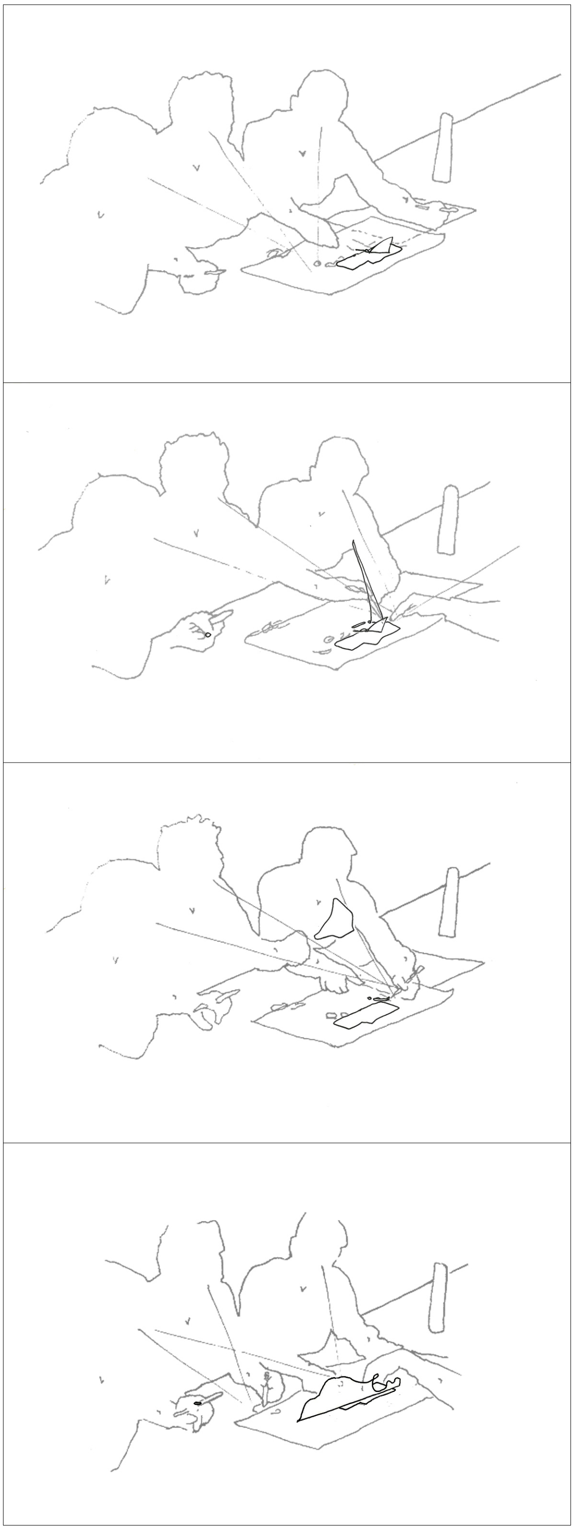


Figure 5.31: Integration study 1. Initial study merging human figures with vector-based field inscriptions.

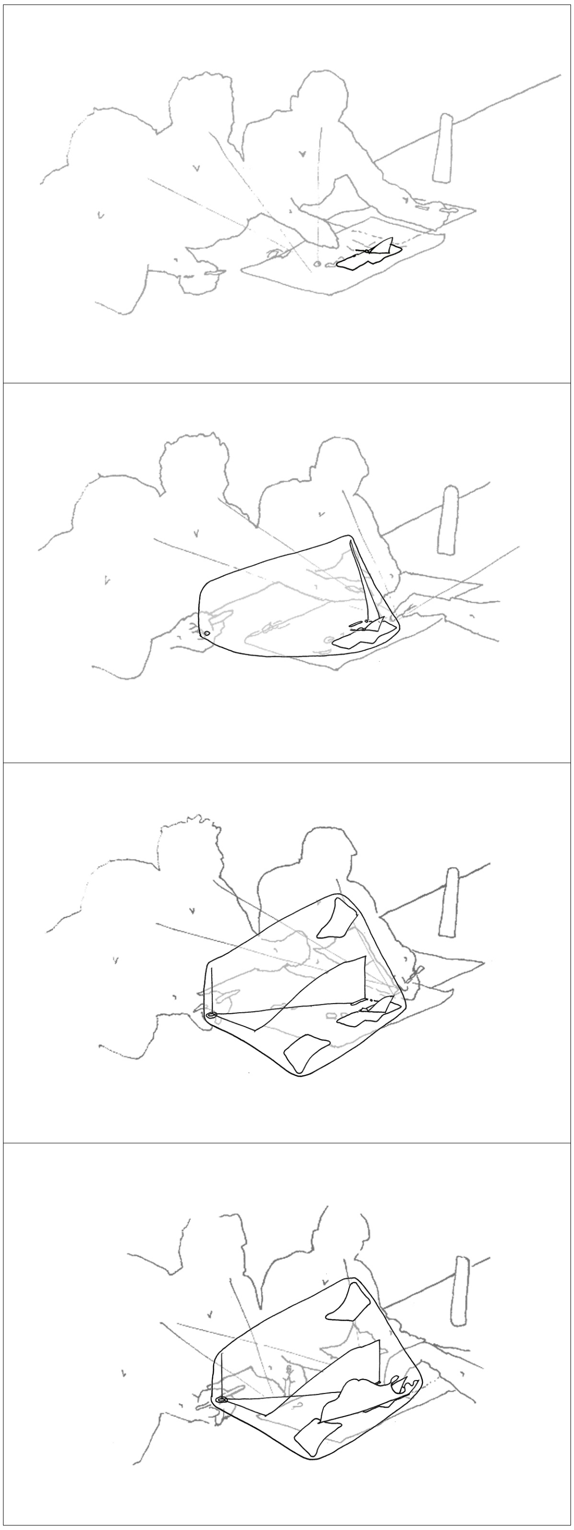


Figure 5.32: Second study for the integration of human figures and other inscriptions. The looped shapes around gestures, lie within larger units of shared space.

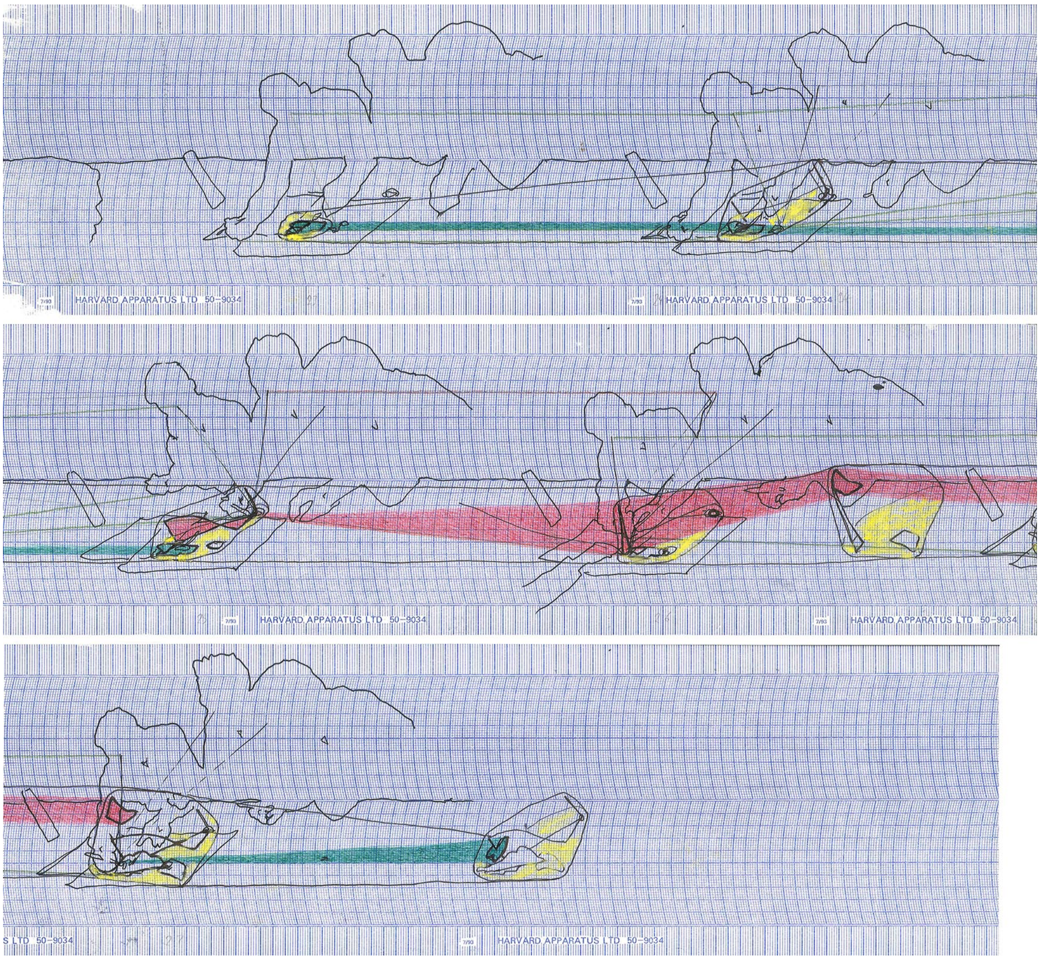


Figure 5.33: Integration study 3. Working drawing for the coding of qualitative spaces. A representative portion of Clip 1 is drawn with a rich combination of 1) gesture pathways or vectors, 2) field inscriptions, 3) human figures, and their gaze patterns.

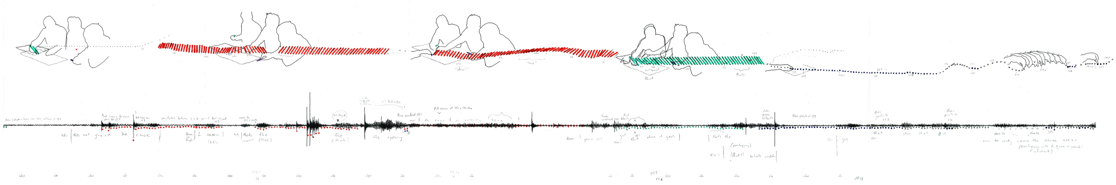


Figure 5.34: Comparative early study to the previous Integration study 3.

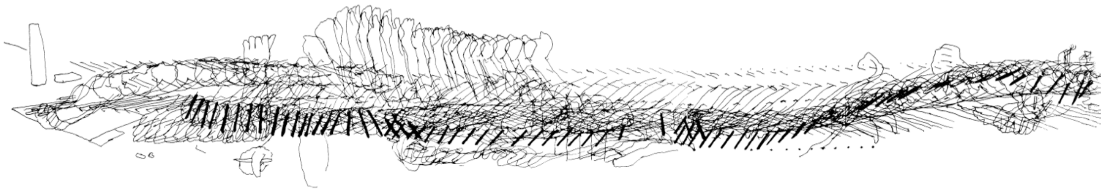


Figure 5.35: Three speech turns, drawn as a horizontally displaced ‘space-time worm.’ Including the hand and forearms of figures.

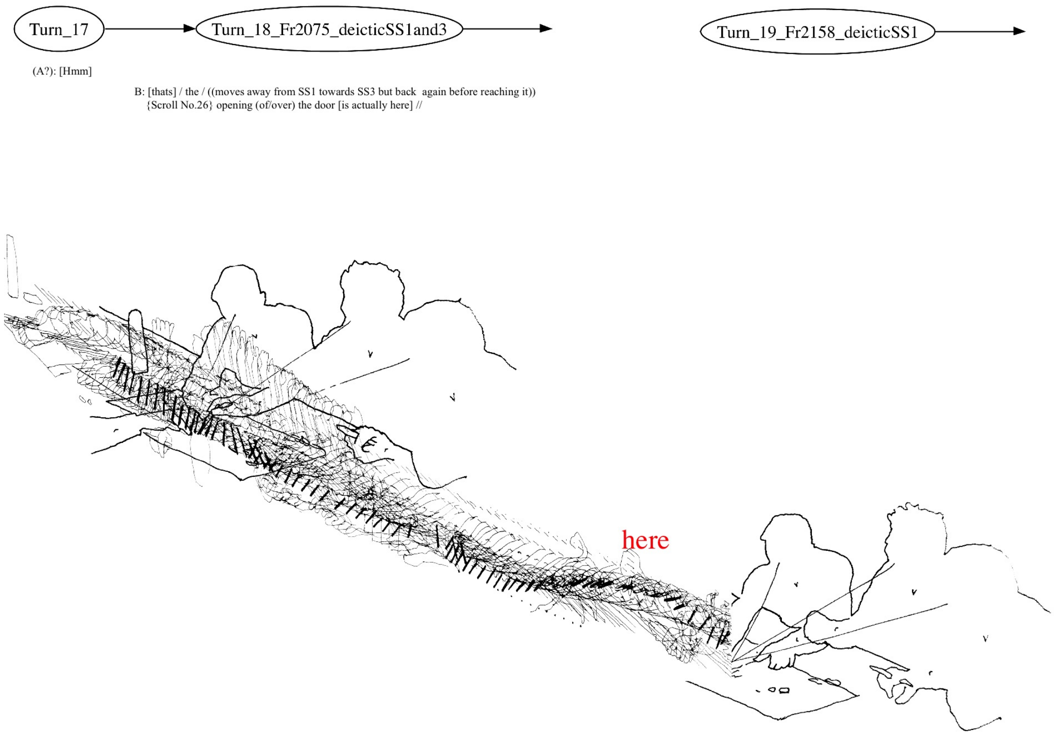


Figure 5.36: Three speech turns, shown as a diagonally displaced ‘space-time worm.’ Including speech and figures, and sight-lines. The red text ‘here’ shows the placement of ‘the opening above the door’ within subspace 1. It is seen on the context of the displaced gestural vector. (Turn numbers were later revised).

and Fig. 5.7). The former relied upon sparse vectors in combination with lateral displacement and elements of the environment and figures. The latter also displays a similar environment and figures, but translates vectorial information into fields that metamorphose over time. This is a manually constructed lateral graph of qualitative space, whose structure is considerably more articulated and variable than a snaking worm.

The segment of scroll is composed of several differently constructed spaces that are combined into a single representation. Some are finer grained and others are coarser with a wider catchment area. These are all mapped onto consistently drawn outlines of human figures. Smaller gestural subspaces (green and red areas, coded to individuals), grouping of shared spaces (whose base is coloured yellow), and gaze patterns (linear marks colour-coded according to person). Different types of groupings visually transform across spatio-temporal expanse. Smaller subspaces relating to specific Turns are maintained as instantaneous views, at appropriate distances along the scroll, which allows for them to be grasped more easily by the viewer. This strategy provides finer granularity at the level of detail that is needed, while the coarser field inscription adds an overview of the broad transformations during the clip excerpt. The proposed solution shown here, is therefore a type of dual-band representation.

In conclusion we can say the methods described above, and the results achieved from exploratory testing of these methods, have answered the requirements of i). inadequacies in current drawings of interaction as found in the literature, and ii). the requirements identified as emerging from reconstructions of the present data extract using conventional methods.

The following is a listing of issues from the survey that can be considered important to representing qualitative space in human interaction. These items could also be described as inherently resistant to description with photographic stills on their own. This is not intended to be an exhaustive listing, but shows the type of complex phenomena that require attention, and that provide a challenge to existing mediums of representation. Each of these points have been addressed by the drawings in this chapter, and these are referenced beside them.

5.5.1.2 ***Requirements***

Drawing techniques:

1. The potential for participatory involvement of the observers of interaction, as seen in the drawings of artist Van Veen (Sect. 2.1.4.1). Drawings were made while attending meetings and watching speakers for example (Fig. 7.16).

2. The requirement to develop a more varied topography of interaction, featuring topical space (Sect. 2.2.7). Drawings were made that describe how this topography of movement is populated with communicative content (Fig. 5.33, 5.36, and 5.34).

3. The ability to make a spatially determined but also interpretative account of phenomena such as 'catchment' and growth points, articulating their qualities as spread over time. Such drawings would provide a multi-dimensional view of the topical spaces (Fig. 5.24, and 5.25).

Requirements related to interactional phenomena. There are specific examples of such phenomena discussed in the literature, requiring improved or innovated visualisation via drawing, and some specific examples of drawings that meet these demands are also given here:

1. The requirement to draw a 'rich' picture of the space to which all members of a group have access (the o-space), and to contribute towards a greater understanding of the functioning of this space (Sect. 2.1.2). Drawings of (Fig. 5.11, and 5.10). As well as articulating the o-space these drawings should also capture the phenomenon of 'catchment' or visuo-spatial deixis (Sect. 2.1.4.2), especially if allied with a transcript (Fig. 5.18).

2. The requirement to show the 'rapid plastic remapping of near and far' and other qualitative attributes of non-metric space, as they are felt in peripersonal space and in shared space (Sect. 2.1.5). The drawings of projected spaces in different possible configurations of intended use for example (Fig. 5.14, and 5.15).

3. The requirement to describe the 'laminations' or layerings of semantic meanings within 'narrated spaces' (Sect. 2.2.1, and 2.1.3). Digital drawings for example, where small volumes of particular qualitative interest have been selected from larger scenes, and are one way of representing this lamination effect (Fig. 5.25).

4. The requirement to track 'shifting indexicals' and effects of spatial non-contiguity deliberately created for the purposes of communication (Sect. 2.2). Drawings were made showing a twisted ribbon shape, representing where the subject was simultaneously transferring his spoken referent from one plan onto another in a different projection (see the third panel of Integration study 2, Fig. 5.32). Another example of this is seen in the testing of alternative configuration of topical spaces (Sect. 5.4.3.3, Figs. 5.14, and 5.15).

5. The completion of (or addition to) spatially nuanced iconographic gestures that are initiated by one participant and continued (or added to) by a collaborator. For instance, in the context of mathematical teaching, gesture space is used in everyday teaching interactions (Sect. 2.2.8). Several drawings in this chapter relate to this type of phenomenon, as found in the architects data. Here, the base of the triangular shape is jointly constructed (see Sect. 5.5.1.1), for example, see the second panel of Integration Study 1, Fig. 5.31).

Chapter 6

Watch the hands: Participatory workshops investigating the utility of field inscriptions

6.1 Graphic enquiry

This chapter investigates the utility of field inscription as a method of graphic inquiry for researchers in human interaction. In order to facilitate the iterative development of the drawing method in collaboration with its possible users a participatory workshop approach is used. This addresses the practical question of whether people can successfully apply this technique in the course of their own research. It also allows us to explore in depth the specific strengths and weaknesses of field inscription in uncovering uses of shared space in different samples of interaction data. The main research question addressed is:

> Does the process of drawing, following a field inscription-based protocol, help to uncover the qualitative structure of interaction spaces?

Specifically:

> Drawings that use the method to test hypotheses about shared space in a speculative

> but methodologically rigorous way. For this to be the case, there should be evidence that the drawings have been tested against one another and against the empirical evidence of video footage. Working drawings should show systematic development of visual inscriptions, possibly leading to a repositioning of the analysis, made in the light of a close examination of the data through drawing.

Where do researchers set boundaries of qualitative spaces? Do their drawings help them to understand interactional spaces as being shared, or not? If an outlining mark is made in one area but not in another, can this be understood in rigorous relationship to the data? How do researchers frame their own understanding of qualitative space, and what role do boundaries play in this?

6.2 Workshops Design

Three exploratory workshops were carried out with human interaction researchers, in order to understand how they might use drawing techniques to develop representations of qualitative and shared interactional space.

The methods chosen were designed to facilitate a reflective drawing practice, allowing a detailed form of graphic enquiry to emerge from the study of the raw data. The approach was to provide to opportunity to participants to pursue their previous research interests while using a set of three key guidelines for drawing. In this way, the workshop methodology should gather information about how researchers adapt to the provided framework, and find their own ways of attaching observations about qualitative space to their data, through the process of making drawings.

The consistent format of the workshop materials and tasks were designed to enable researcher's drawings to be structurally and developmentally compared. The particular goal is to find out where they place their mark concerning the boundaries of empirically observed interactional spaces. The results from these workshops take the form of sequences of drawings, layered transparent acetate sheets, of distinct spaces and segments of time.

The workshop tasks were designed as discrete stages in order to ease the process of drawing for those who may not be confident with it. The design was also intended to highlight any insights that may have been gained at different stages of the observational process and while different guidelines were being followed. The workshops created an arena for the following operations upon the data:

1). Structural organisation within the data, including gesture-pathways and physical spaces.

2). Gesture-paths distinctively and non-trivially joined into fields.

3). Subsequent re-organisation of these fields at points throughout the duration of the data excerpts.

Self-selected drawings inform us whether the drawings are seen by the participants as having facilitated the process of analysis, and whether this constitutes an insight that has been gained through the process of drawing. 'Mistakes' and 'errors' in the drawings, are placed on an equal footing with drawings that are not described in such a way, because they demonstrate the ways in which problems were stated in visual terms, and how they were then overcome. Self-dismissed drawings show how improved analysis can arise through a series of works progressing towards greater understanding. The necessity of making clear the route that was taken towards a solution, is fundamental to many disciplines (Sect. 1.6).

6.2.1 Workshops rationale

A key precept underlying the design of the workshops is that researchers could interpret instructions in a way that they could be related to their own interests. Using the guidelines effectively, entails that researchers would be able to determine a set of parameters for shared spaces that is suited to their own data and research methods. The notion of shared space is relatively abstract and theoretical, so it cannot be taken for granted that researchers will want to include this in their protocols. Hence the rationale for these workshops is to translate this notion of shared space into an equivalent description made in terms of the observable field conditions.

6.2.2 The protocol steps

The ways in which the participants were prepared for the tasks fell into two categories: i). generalised guidelines, to initiate the drawing tasks, and ii). optional secondary suggestions about how the drawing tasks might be developed beyond the initial guidelines and be adapted to working with their own data.

The instructions (see below) were designed to convey the general guidelines and the exploratory nature of the sessions. This text was designed to convey the guidelines and introduce these as exploratory sessions, while also placing the emphasis upon the importance of empirical observation. Other aspects of the guidelines were related to the preparation of the drawing workspace.

> **Tracing from the screen** enables a direct and constant reference to be made to the video. We will progress from drawing small points, to lines suggesting volumes. We will start with black pen, and move on to colour, if needed. Eventually, most likely after this session, we can develop a recognisable line drawing of the people and objects in the scene, so do not worry about making a publishable drawing for the moment. Work as fluidly but also as accurately as possible, finding a balance between the two. Take your time; how long it takes depends entirely on what you set out to accomplish, and also on how complicated your material is, and upon your approach to it.
>
> Think of this workshop as an *exploratory* project. We will use to idea of **negative space.** This refers to **those empty spaces observed between things.** Knowing the names of things sometimes prevents us from drawing them accurately, our knowledge and concepts getting in the way of seeing things as they are as opposed to how we think they are. In other word, it is occasionally better to focus on the things that don't have names, the spaces between things.

Before starting to draw, identify moments in your video data that can be contrasted and compared to one another. Pick a **point** on each of the items that you wish to follow through the video: for example fingertips, or knuckles, or wrist. Begin to draw by marking these points on the first frame, using dots or short lines, as minimally as you can (this prevents large build-up of marks in one drawing). Use different colours for each person. Set up your video software window (in this case Apple's *Quicktime*) to a size where detail is visible, so that there is ample room to draw. Establish registration marks at each corner of the window, these will help with placing successive sheets of acetate onto the screen and maintaining the correct alignment between them.

From this point onwards the basis for these drawings will be making three types of line:

6.2.2.1 ***1. Gesture-Paths***

Plot the motion-paths of items you have selected in your clip, going from frame to frame, or in real-time, following their movements.
(Suggestion: complete these paths, as closed loops, for the purposes of outlining the spaces).

6.2.2.2 ***2. Grouping Paths***

Draw another line grouping a selection of paths from step 1 that have influenced each other (show the connections between events, and group things that are related).
(Suggestion: look at how resting and poised hands create edges to these spaces, and consider how these can be used to link up the paths found in step 1).

6.2.2.3 ***3. Trace Outlines***

Trace simple outlines of any of these: hands, limbs, heads, and any objects from the environment. Choose a number of these and draw them at stages throughout the

video in such a way that will provide context to the marks that you have made in steps 1 and 2.
(Suggestion: these could be at the beginnings and/or ends of particular movements; they can also be separated into different images, each showing the sequential stages of action).

6.3 Workshop aims

This particular graphic method of enquiry is designed to reveal how qualitatively organised spaces are inscribed when using the guidelines given above. The drawing results, post-study questionnaires, and workshop discussions, will be be used to provide an account of whether the drawing methodology has been directly or indirectly useful towards bringing about new insights into the structure of shared qualitative spaces. The aim is test and refine methods, showing how such an approach can be informative, iterative, and can promote insight into the structure of shared space.

The workshops were not intended as road-tests for a near-proven concept. Rather, their interest lies in the exploration of untried waters, with reference to a variety of different scenarios in human interaction. The purpose of this was to examine the underlying expectations and precepts of the method, looking for evidence that will confirm, deny, or adjust the rationale.

6.3.1 Approach and scope

The scope of the workshops was limited to examining whether enquiry was facilitated through the techniques described. Due to this central focus upon graphic enquiry, the drawings made during the workshops do not require to be compared directly with the participant's source data, a process that the expert participants have already carried out for themselves. The purpose of the workshops was to establish whether gains of any kind were made as a result of using the drawing techniques. Participant's drawings and statements should reveal the places where they have tackled detailed problems within their data, in the process of enquiry via drawing.

This can be said to be one of the main tenets of participatory research, or cooperative inquiry. Here, participants bring their own research material and analytic concerns, and their engagement in the workshops is a means of judging whether, on their own terms, specific drawing techniques are a useful method of analysis for researchers. This chapter is structured in such a way to bring out the common threads that ran between the three workshops, while the they were of a more participatory and collaborative nature than it may appear here.

The workshops followed a general inductive approach for qualitative data analysis (Thomas, 2003, and Silverman, 2013). This is based upon Grounded Theory techniques (Strauss and Corbin, 1990, see Glossary. A.0.2.8). The current workshops can be seen as a form of 'cooperative enquiry' aimed at jointly assessing and redeveloping the initial research goals and questions (Reason and Bradbury, 2001). These methods have also been used to investigate responses and relationships to technology (Light, 2006). A subsidiary aim of this chapter is therefore to establish ways in which drawing can enhance existing inductive research practices (Sect. 1.3).

6.4 Workshop Methods

6.4.1 Participants

Seven of the participants were doctoral researchers from the Department of Electronic Engineering and Computer Science at Queen Mary, London, engaged in the study of human interaction, discourse, the modelling of behaviour, and other fields. Of the remaining three researchers one was doctoral and two were post-doctoral researchers from clinical psychology interaction research areas within the Unit for Social and Community Psychiatry Barts and the London School of Medicine, based at the Newham Centre for Mental Health. These researchers share a strong interest in the formal study of human interaction, and are centres of excellence in this respect. Nine of the ten participants were female.

6.4.2 Materials

The workshop required participants to bring a short video clip from their own research, on a USB storage device, and to inscribe upon acetate placed directly onto the computer screen displaying the video excerpt below the acetate. *Apple iMac* monitors and all drawing materials were provided. These and the drawing materials described below were considered to be appropriate to the constituency of the participants, since much of their work is carried on computer and involves scrutiny of video data. The drawing materials are all those which might be found in a research department or university office, and would be used for a range of purposes including the general management of data and workflows.

Materials included individual sets of permanent markers in five colours, adhesive tape, and A3 size acetate sheets (42 x 59 cms). The choice and extent of drawing tools made available to the participants, was designed to facilitate cross-comparison between their drawn outcomes, and also to prevent the participants being overwhelmed by an over-abundance of choice amongst drawing techniques.

6.4.3 Procedure

This series of three drawing workshops were held at Queen Mary, London, between November 2012 and January 2013. Ten participants were spread across three sessions, without repeat attendance (although a number expressed the desire to return). Attendees were asked not to discuss the workshops with people they may have known and who were taking part at a later stage.

Seated before glass-fronted computer screens, participants looked at video data windows. They were given several sheets of acetate to use at successive stages of the tasks, working at their own pace. They were able to hear all group discussions, although the tasks were carried out entirely individually by each researcher, rather than as group endeavours. They were able to see one another's work at different stages, if they wished, although this tended to occur towards the end of the sessions. At the conclusion of the sessions open discussions took place, comparing each others results and experiences.

The instructions were given as printed sheets which could be worked through at individual pace while working at their monitors. Discussions between the facilitator and the attendees were held collectively on questions related to how their data could be drawn using the guidelines. Tailored assistance was given to each attendee, as well as to the group as a whole, and efforts were made to ensure that spoken guidance during these discussions was given in a consistent way. The informal presentation of the workshops, was a setting intended to encourage the development of unique individual insights and practices.

Instructional text included no images, since these may have unduly influenced the drawn outcomes. No theoretical background information was referred to in the instructions.

6.4.3.1 ***Research position***

The workshops were presented as a semi-formal study, with printed guidelines, questionnaire and participants working separately in the most part. This is a form of research that the participants would be well acquainted with, having operated their own studies on many occasions. However, the workshops differed from this in that the facilitator was on hand throughout with additional guidance, support, and availability for discussions of all kinds. The research position was therefore a mix of conventional task-based experimental methods, and a participatory and highly practical element. At the conclusion of the sessions open discussions took place, comparing each others results and experiences, in a way that would not occur in the type of experiments run by the participants themselves.

Viewed in this light, the workshops could be seen as a form of action research involving group activities of ‘shared diagramming’, made in isolation to begin with, but discussed as an innovation for potential adoption by the group as a whole at the conclusion (Chambers et al., 1997, p.192). The community identified for involvement in open-ended and participatory research processes, is in this case the community of researchers whose topic is human interaction. The present author has worked alongside this community and developing a familiarity with the type of methods and questions that arise in this community, and within this context has tested forms of drawing and other visualisation that seek to develop a critique of these methods using variations of them recognisable to the same research community. This underlines the importance to the workshops of the use of appropriate technology to the domain. The results of the workshops were also subsequently shared with the community this research has originated from (seminars, exhibiting and follow-up sessions with the participants).

6.5 Workshop results

Results are presented here according to the measures that were taken during the workshops: i). the detailed analysis of the drawings themselves, ii). observations of the participant's drawing practices, iii). the informal post-workshop discussions, and iv). questionnaire results.

6.5.1 Workshop drawings

Here the drawings of each participant are presented, as well as brief descriptions of what their data and research relates to. Their individual drawing style and how they chose to interpret the guidelines, is also summarised. The drawings and observations of the practices are also discussed in the following sections.

The output of each of the participants has been assigned a value in terms of the depth and breadth of their attempted representations of qualitative space. These fall into the general categories of:

- Sparse (or 'thin'); restricted to body surfaces, and/or vectors extending from limbs.
- Bounded (or constrained); areas on and around limbs and torsos created by a gesture, for example.
- Rich (or 'thick'); areas between and around people, specifically reflecting their joint manufacture (as opposed to those that are created by the movements of individuals).

Of the ten participants, four are judged to be in each of the last two categories: bounded and rich. The remaining two researchers fall into the sparse category (Table. 6.1, and overview composite Fig. 6.35).

Each participant's outputs drawings are presented below in the following ways:

- **Column of results.** Each participant's drawings are shown from earliest (top) to last (bottom), giving their development over time and task.

- **Qualitative field inscriptions.** The drawings relating to Guideline 2 (Sect. 6.2.2.2) are reproduced on their own.

- **Self-selected drawings.** Chosen by the participants in response to the facilitator's question: 'Which drawings do you feel come closest to expressing the view of the data that you have now arrived at?' These are shown superimposed if required.

- **Erroneous drawings.** Self-described, reflecting advancements of analysis made through the process of drawing.

6.5.1.1 The drawings: sparse representations

6.5.1.2 SD

(female, in her 30's), made four drawings of a teacher and student musical tuition interaction (Fig. 6.1). No self-selection was made from the drawings (those that might in conjunction be used to depict the interaction), and no self-described errors were designated.

SD was reluctant to follow step 2 of the guidelines ('grouping together the paths', Sect. 6.2.2.2), and **SD**'s detailed and exact drawings confined her inscriptions of qualitative spaces to the smallest possible areas of strictly observable space. She did not link any of these smaller data-points into larger fields. These were smaller units of analysis, recording singular spatial points, marking of head, hand, or body positions that she had previously identified as linked to an interpretation of the coordination between the player and teacher.

Figure 6.1: **SD, column of results.**

Figure 6.2: **SD, all four drawings superimposed.**

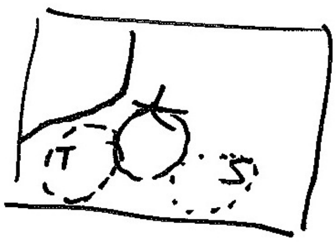


Figure 6.3: In discussion and upon accompanying papers, **SD** drew a diagram of the **'workspace bubble'.** This is a redrawing of her previously published graphic. Showing the piano edge at left, music stand at centre, and dotted personal areas for teacher ('T') and student ('S'). Between and overlapping these is an encircled area (solid-line) where the interaction is jointly managed. The diagram is not to the same scale as other drawings, and the figures are placed as if the camera were at the top edge.

6.5.1.3 ***SO***

(from Newham, male, in his 20's), made a total of 4 sheets of drawings of a seated multiparty therapeutic session (Fig. 6.4), of which the last was a description of the qualitative spaces, denoted by outlines of the moving hand of a central standing figure amongst a group of five subjects (Fig. 6.5). **SO** made no self-selection of his drawings. These drawings appeared to be a familiarisation with data that was relatively new to his research in clinical psychology interaction.

While **SD** drew points, **SO** drew small areas, as if they were discrete fields: the outlined hand as it travelled in a wide arc between the seated figures (Fig. 6.5). This tightness of the field outline restricts the representation of qualitative space to the hand shapes that are immediately visible (and not those occluded). This clip contained the most emphatic and expansive bodily behaviour, and this could have been seen as an opportunity to represent the sweeping hand and arm gesture as a dynamic field.

6.5.1.4 ***The drawings: fields of individual and shared gesture space***

6.5.1.5 ***IB***

(from the COGSCI group at Queen Mary, London, female, in her mid 30's), made a total of seven sheets of drawings of a discussion and disputation held in academic surroundings (Fig. 6.6), of which two explicitly referred to qualitative spaces as their subject matter (Fig. 6.7). Her self-selection consisted of a set of paired and superimposed drawings: number 1 (or 3) placed over 3A; these were paired with another set of superimposed drawings, numbers 4 and 5 (Fig. 6.8). They were contrasted in order to bring out **IB**'s interpretation of the interaction, closely tied to the dialogue. She employed black for the current speaker, and red for the primary addressee, and other listeners. In common with workshop participants **SD** (Sect. 6.5.1.2) and **SO** (Sect. 6.5.1.3), who operated with a sparse conception of qualitative space, she first drew bodily outlines and postural changes before moving on to field inscription.

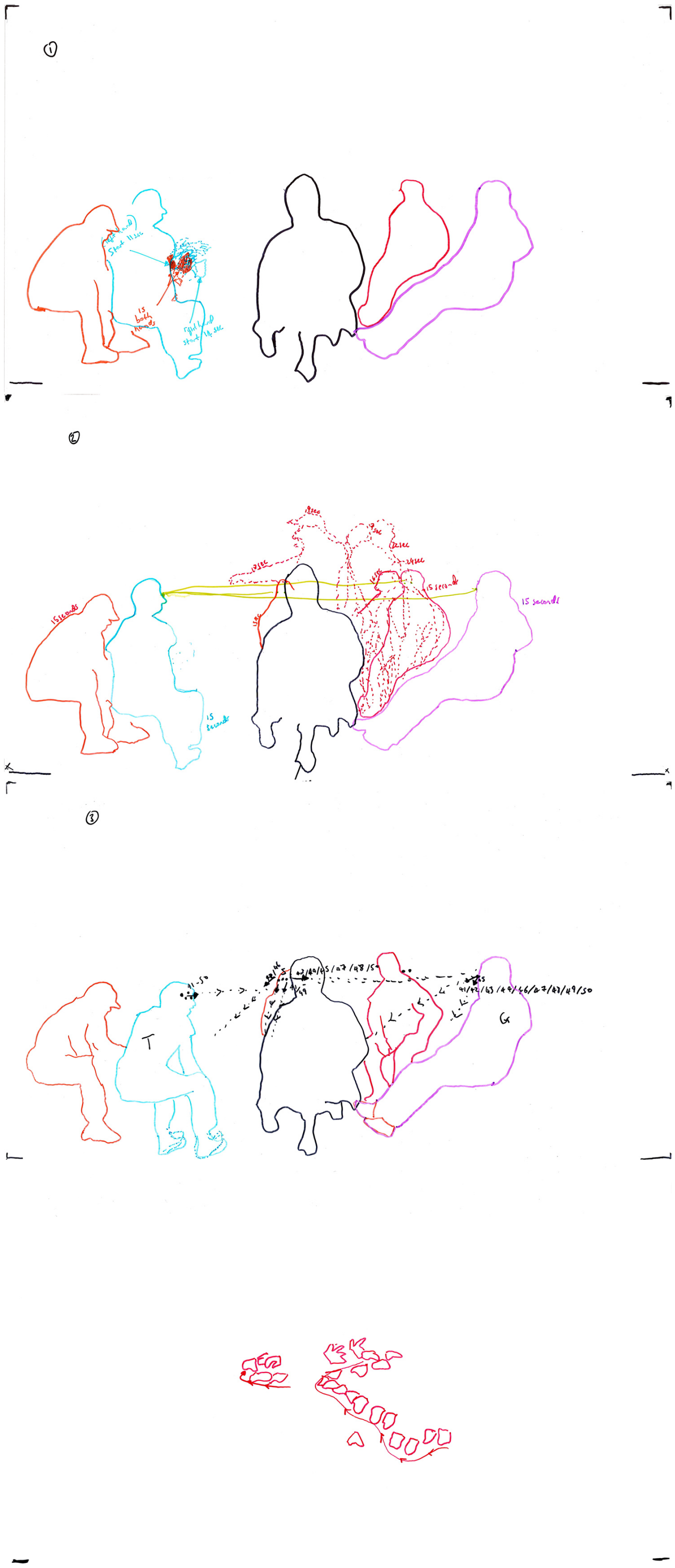


Figure 6.4: **SO, column of results.**

Figure 6.5: **SO, qualitative space drawings.**

For **IB**, drawing her clip in such detail clarified the spatial patterns of the subject's utterances of 'closure' and 'openness', in relation to the operative noun 'community', as used by different speakers. The 'community' gesture was seen as a 'funnel' or 'bowl' (see two lower drawings in Fig. 6.7). She found that contrary to what might be expected, the two speakers who were in disagreement with each other also produced rapid re-mappings of space. The opening gesture was accompanied by the utterance 'closed', while 'open' was accompanied by a closing action. **IB** found that visually collating these components, in separate layers of drawings made by hand, allowed her to see relationships that were of interest. **IB**'s drawings articulate a discourse pattern, similar to 'catchment.'

*6.5.1.6 **ML***

(from Newham, female, in her mid 30's), made a total of seven drawings on five sheets of acetate relating to three figures in a motion-capture study, one of whom was a clinical patient with depressive symptoms, a fact unknown to the others (Figs. 6.9, and 6.10). Working in clinical psychology interaction research, **ML** said she was: 'interested in how the patient is oriented towards by others, in particular whether there is a difference between responses to patients with these symptoms, compared to those with more active symptoms'. The hypothesis was that such a patient encourages more active responses in those interacting with them. She made no selection of drawings, but compared the success of some of the four drawings of qualitative space to others (Fig. 6.11). **ML** had drawn fields as relatively constrained to areas around the gesture-paths observed in the earlier stages of the workshop. Compare other results where drawn marks establish a close identity between paths and qualitative spaces (Sect. 6.5.1.2, and 6.5.1.3).

ML was first inclined, as was **IB** (Sect. 6.5.1.5), and **SD** (Sect. 6.5.1.2), to follow and draw the entire visible outline of a hand or arm, from frame to frame, but soon altered this approach, finding that drawings became too cluttered. Some rounding of the field outlines occurred when retracing these paths more fluently during a joint graphical enquiry initiated by the facilitator

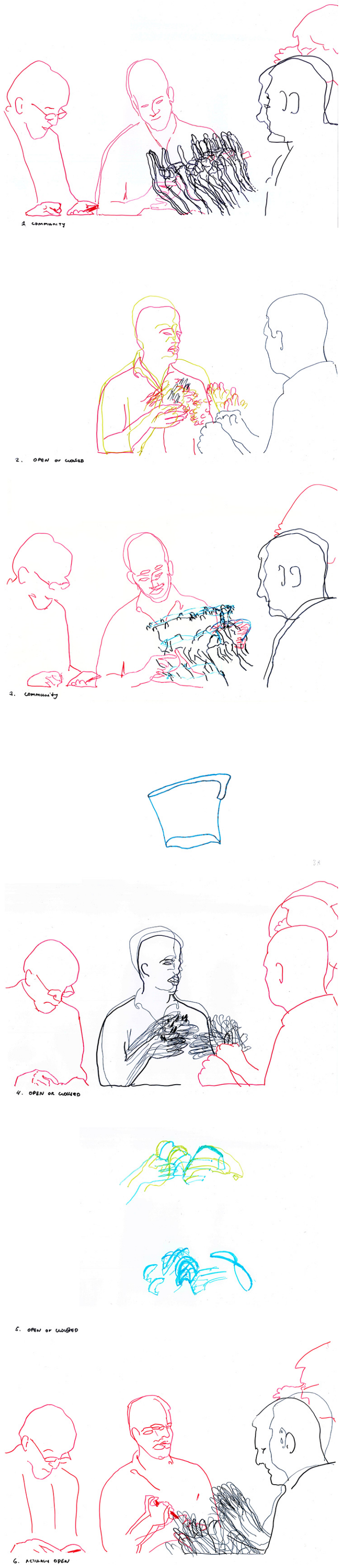


Figure 6.6: **IB, column of results.**

Figure 6.7: **IB, qualitative space drawings.**

Figure 6.8: **IB, superimposed self-selected sheets.**

(Fig. 6.13). This retracing was made by **ML** to show three stages of an evolving qualitative space, that she had identified but had found difficult to extract from her own drawings. Further time would have alleviated this pressure.

6.5.1.7 ***SC***

(from the COGSCI group at Queen Mary, London, female in her mid 20's), made a total of seven sheets of drawings of two seated figures in public debate showing strong ideological disagreement (Fig. 6.14). Four of her drawings showed inscribed fields (Fig. 6.16). The sheet containing drawings C and D was dismissed as an error (Fig. 6.17). Her self-selection consisted of superimposed drawings A (singular data-points), plus B (gesture-paths and physical context), and C (enclosed loops around gesture-paths) (Fig. 6.15).

SC's drawings numbered 1 and 3 marked portions of the gesture spaces of each of the two speakers in green. These were grouped as a field by a solid black outline, following the second drawing guideline (Sect. 6.2.2.2). The black line travels around but generally does not touch the slightly smaller green areas. Fields are linked by generally thinner causeways in black. The effect is of flattened interlinked areas rather than of multi-dimensionality.Some comparison can be made with the mode of representation that is seen in the highly coloured and dynamic anatomies of *Kinect* skeletons. **SC** has drawn several segments of the interaction in this way. Drawings 1, 2, and 3 contain short lines emanating from eyes that indicate gaze direction, a feature of these digital skeletons.

6.5.1.8 ***KP***

(from the COGSCI group at Queen Mary, London, female, in her late 20's), was unique within the participants of the workshop because animations of simulated human behaviour were used as

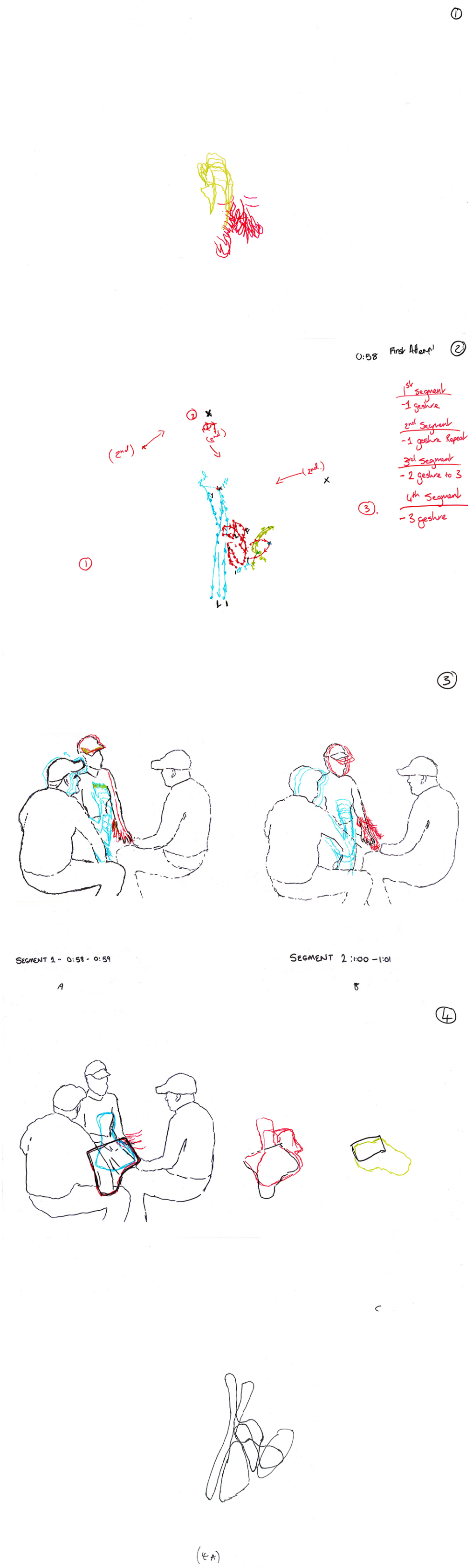


Figure 6.9: **ML, column of drawing results.**

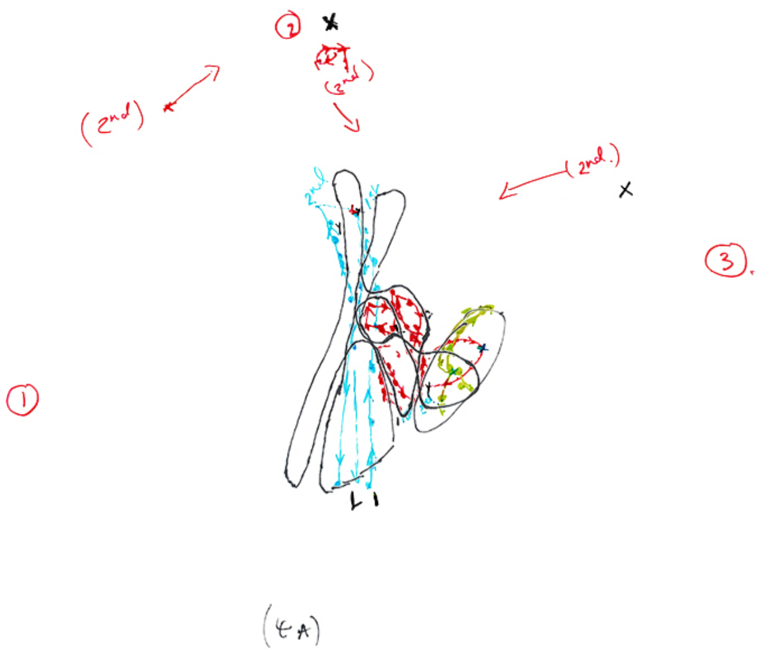


Figure 6.10: **ML, the superposition of qualitative spaces and gesture-paths.** **ML**'s drawn acetate sheets superimposed, excluding the outlined figures and earlier trial-runs of qualitative space outlines, for the sake of clarity. Head positions are numbered here in red, 1-3.

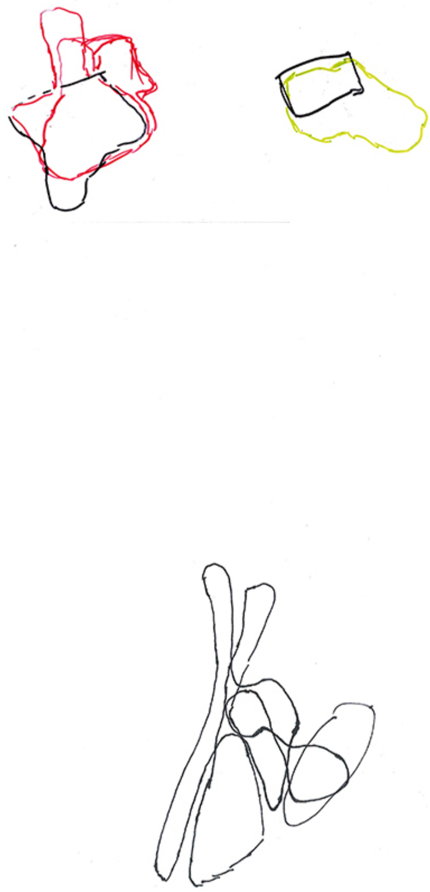


Figure 6.11: **ML, qualitative space drawings.**

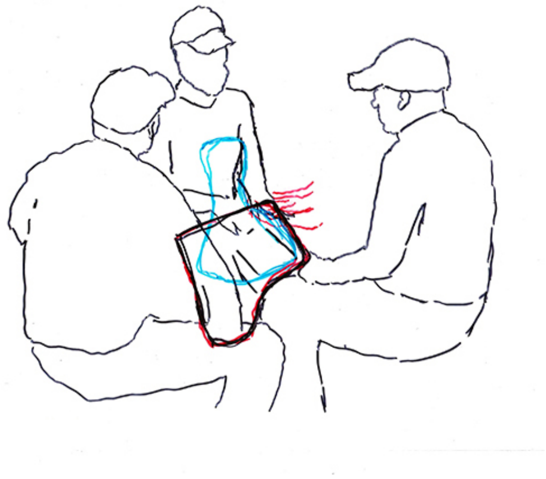


Figure 6.12: **ML, erroneous drawings.**

Figure 6.13: **ML, retracing of three stages of evolving qualitative spaces.** Sequence of marks subsequently reconstructed from the last version of these spaces drawn by **ML** (See Fig.6.11).

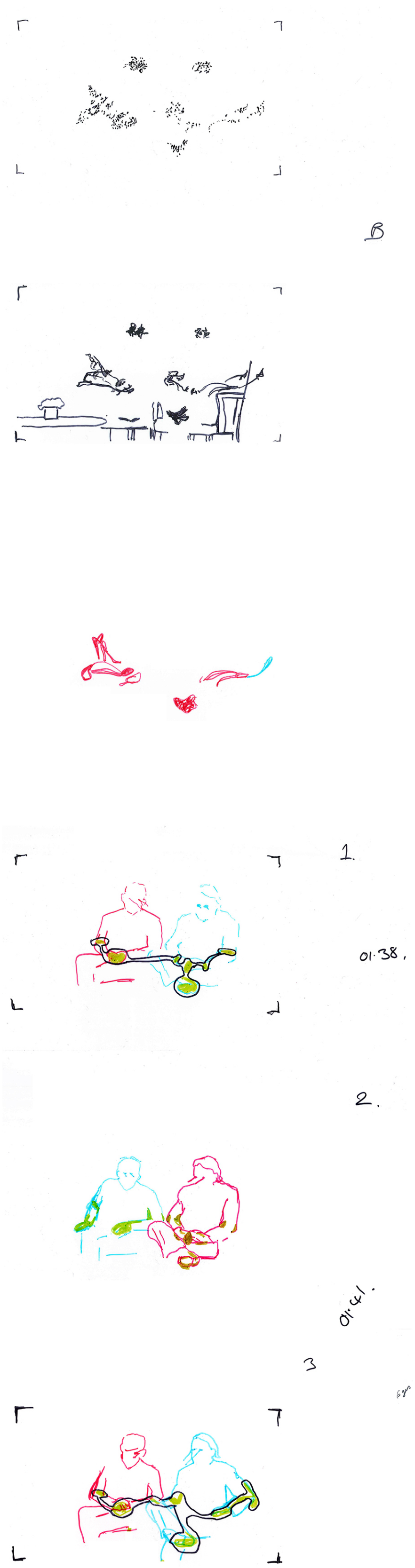


Figure 6.14: **SC, column of results.**

Figure 6.15: **SC, superimposed self-selected drawings.**

source material for the drawings instead of ethnographic video. Referring to the spatio-temporal schema of Kendon (Sect. 2.1, and 4.0.2), she used different colours (for the *r-space*, *o-space* and for a *group revamp*), to record where the animation shows interactional groups forming and breaking up. She asserted that colour was being used to code time and space (Fig. 6.18).

The penultimate sheet 5 (Fig. 6.19) was a turning point in this regard, from having initially seen the spaces as geometric artefacts of programming, to seeing them as three-dimensional fields that were going through phases of reorganisation and instability. These drawings are constrained to the extent that the fields do not extend beyond the immediate body and foot positions, and so are body-centric in conception. The solid colouring used at head and foot height make the spaces resemble transparent sharp-cornered containers.

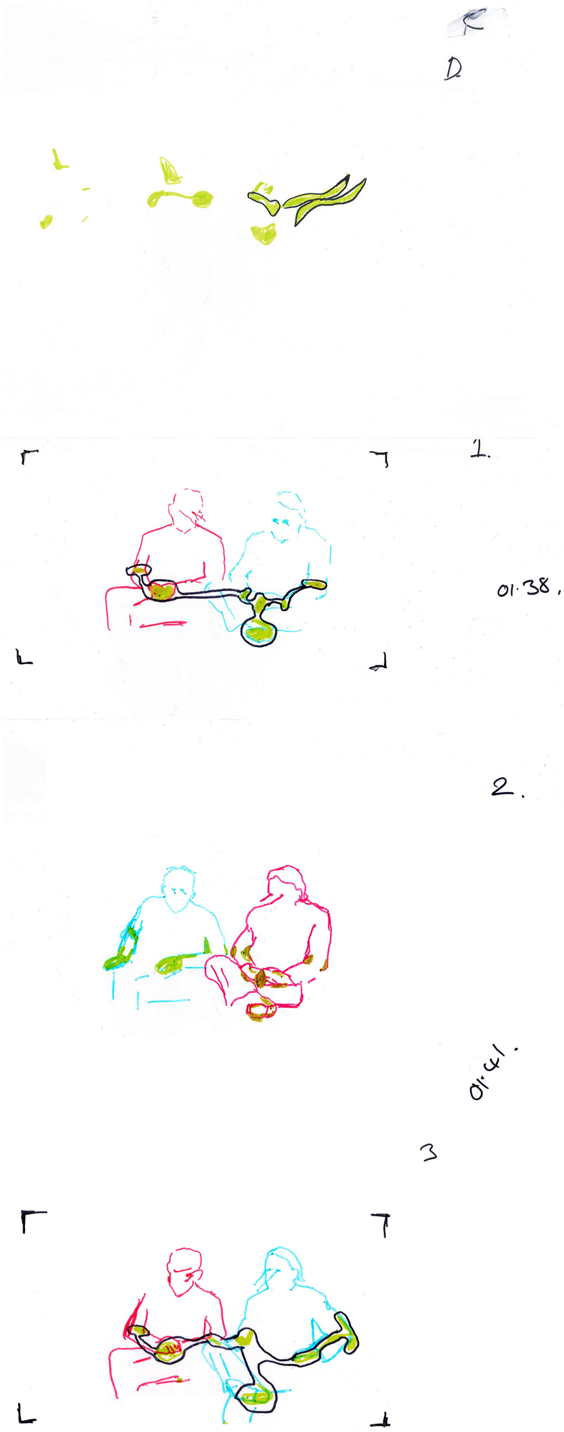


Figure 6.16: **SC, qualitative space drawings.**

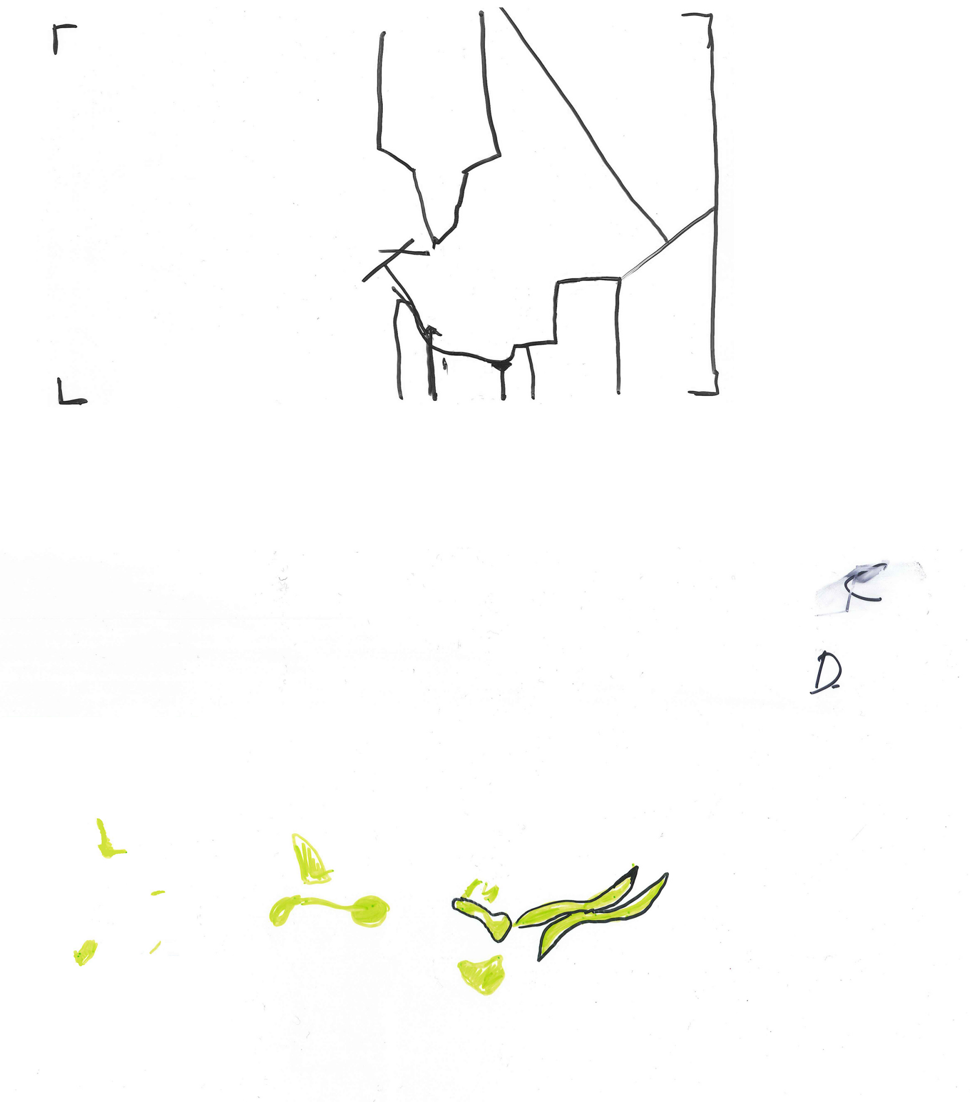


Figure 6.17: **SC, erroneous drawing.**

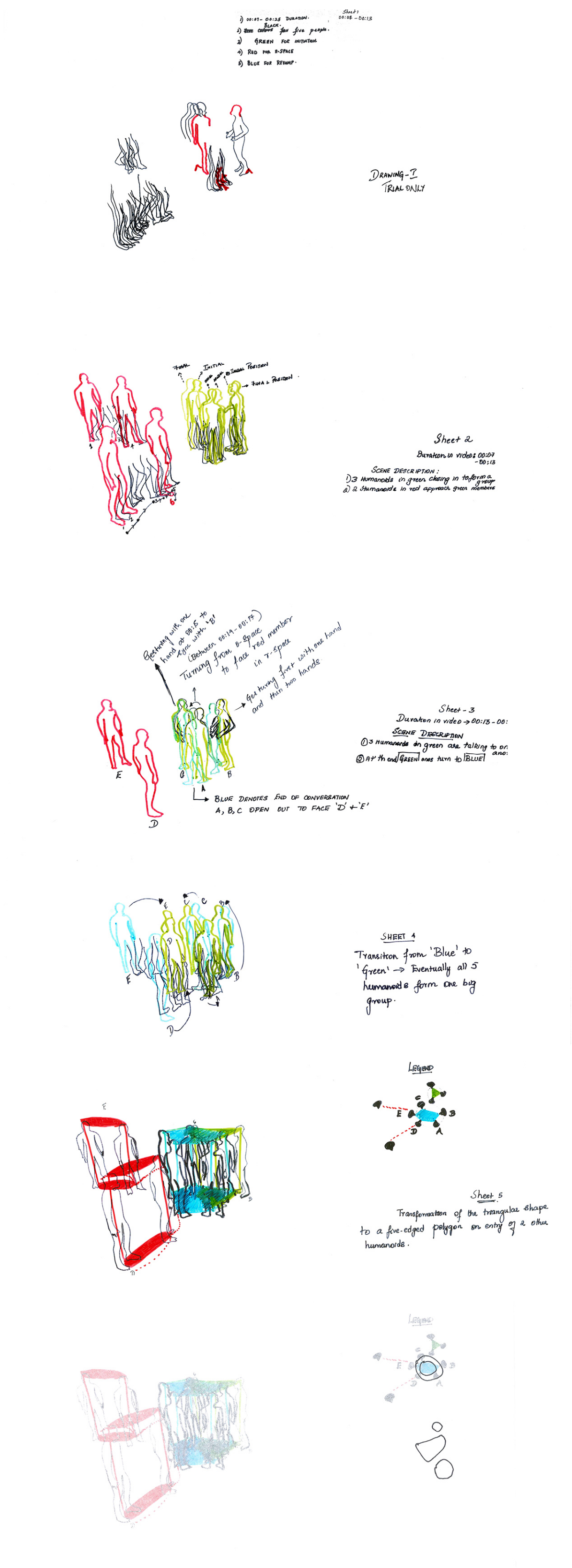


Figure 6.18: **KP, column of results.**

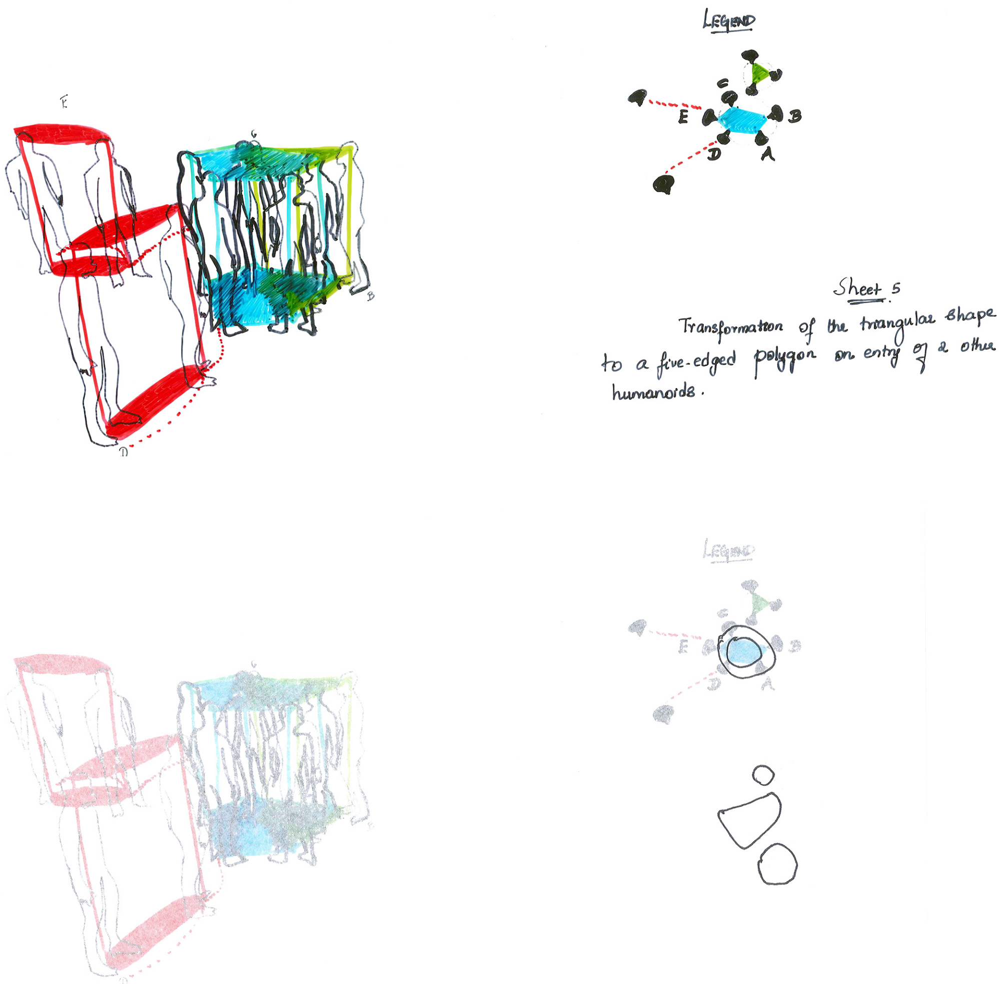


Figure 6.19: **KP, qualitative space drawings.**

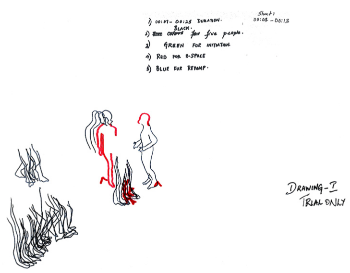


Figure 6.20: **KP, first drawing, described as 'trial.'**

6.5.1.9 ***The drawings: expansive fields of shared space***

6.5.1.10 ***LT***

(from Newham, female, in her early 30's), studied an excerpt from dyadic footage of a psychiatric consultation between doctor and a patient diagnosed with schizophrenia. She made a total of seven drawing sheets (Fig. 6.21) of which three referred to fields of changing qualitative spaces (Fig. 6.23).

Clearly traced gesture-paths are shown for both doctor on the left, and patient, on the right (Fig. 6.24). **LT**'s preference was for modelling of fields as curvilinear, shell-like, or cloud-like shapes. These change shape over time and are strongly related to speech and gesture (Sect. 6.22). The drawing process has been taken as an opportunity to reformulate the sum of the parts of her data, looking at it in a way different from a mere recapitulation of the raw data-points in the self-dismissed drawing. The third guideline (Sect. 6.2.2.3) relating to adding human figures, successfully added a narrative dimension to the spatial information given by the field inscriptions which had tended to be drawn with relatively unconstrained outlines. Had she drawn the figures first, her subsequently drawn fields of qualitative space may have been more tightly constrained to the narrative. This is a feature of the iterative process that all workshop results display.

6.5.1.11 ***PB***

(from the COGSCI group at Queen Mary, London, female, in her early 30's), made seven sheets of drawings of the co-presence interactional effects of remotely situated dining tables, where two projectors transmitted moving images of diners interacting remotely (Fig. 6.25). Drawings show the separated parties of the interaction within one sheet. Her self-selection of these consisted of drawings 2, 3, and 4 (Fig. 6.27). No sheets were discounted as errors. Noticeably, she drew no outlines of people, as was partially the case with **NP**'s drawings (Sect. 6.5.1.12). This may be due to the overhead view of the two cameras over each table.

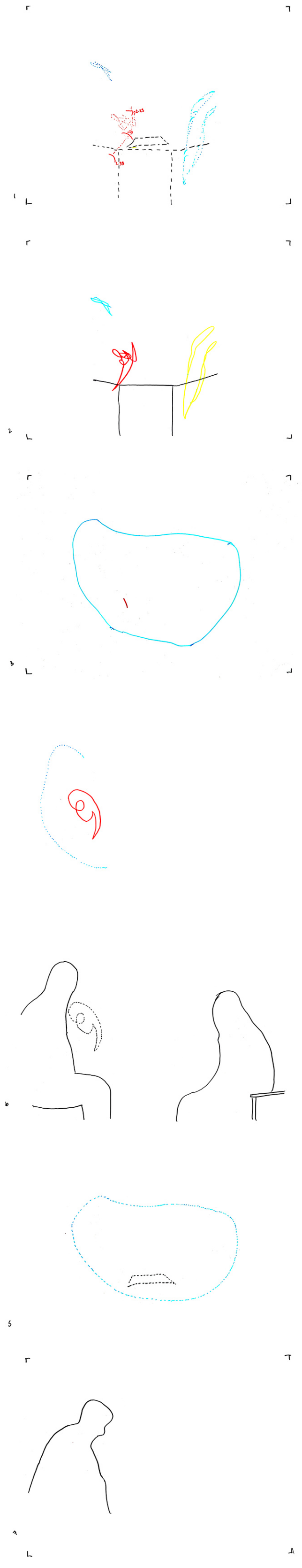


Figure 6.21: **LT, column of drawing results.**

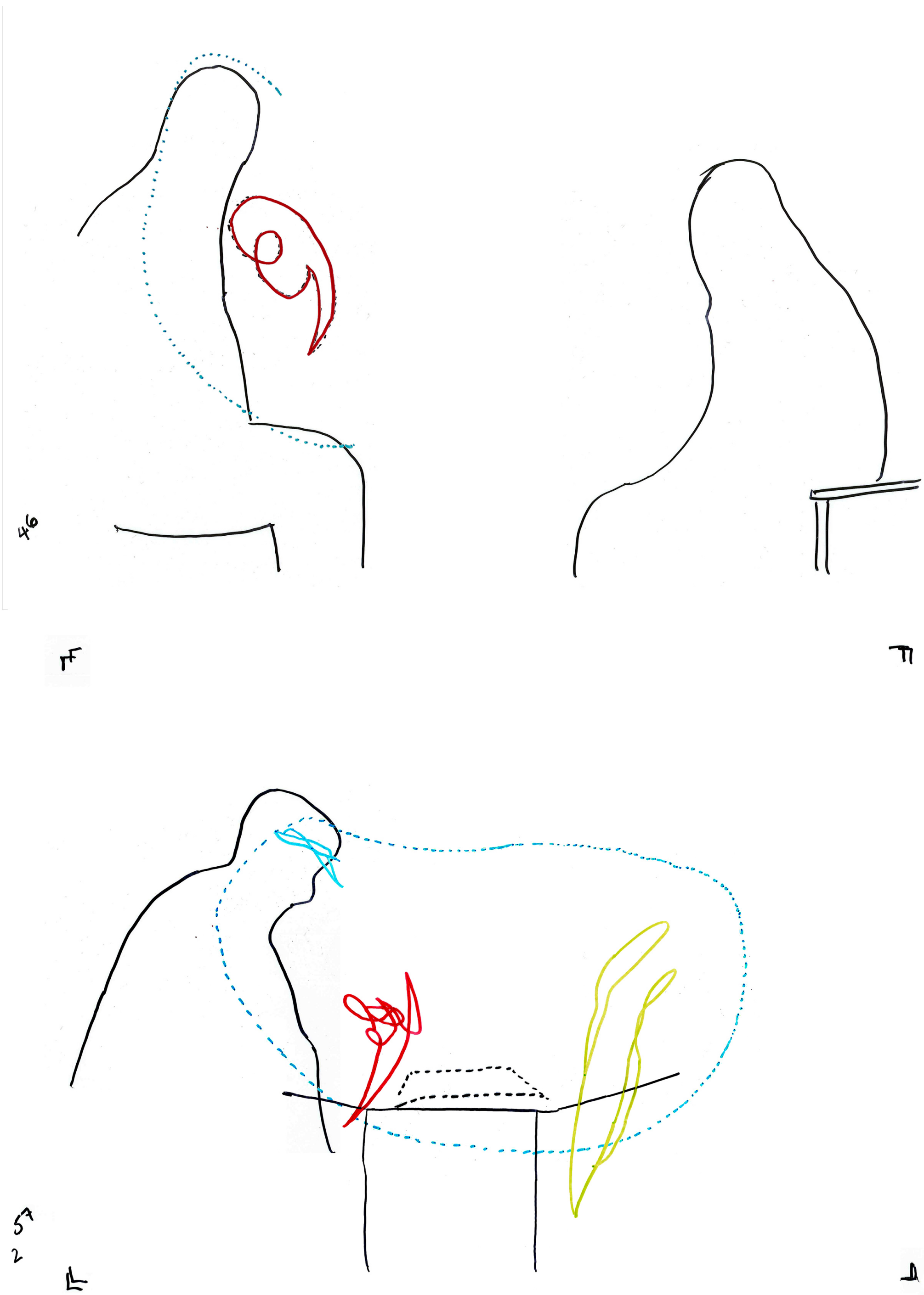


Figure 6.22: **LT, overlaid self-selected sheets.**

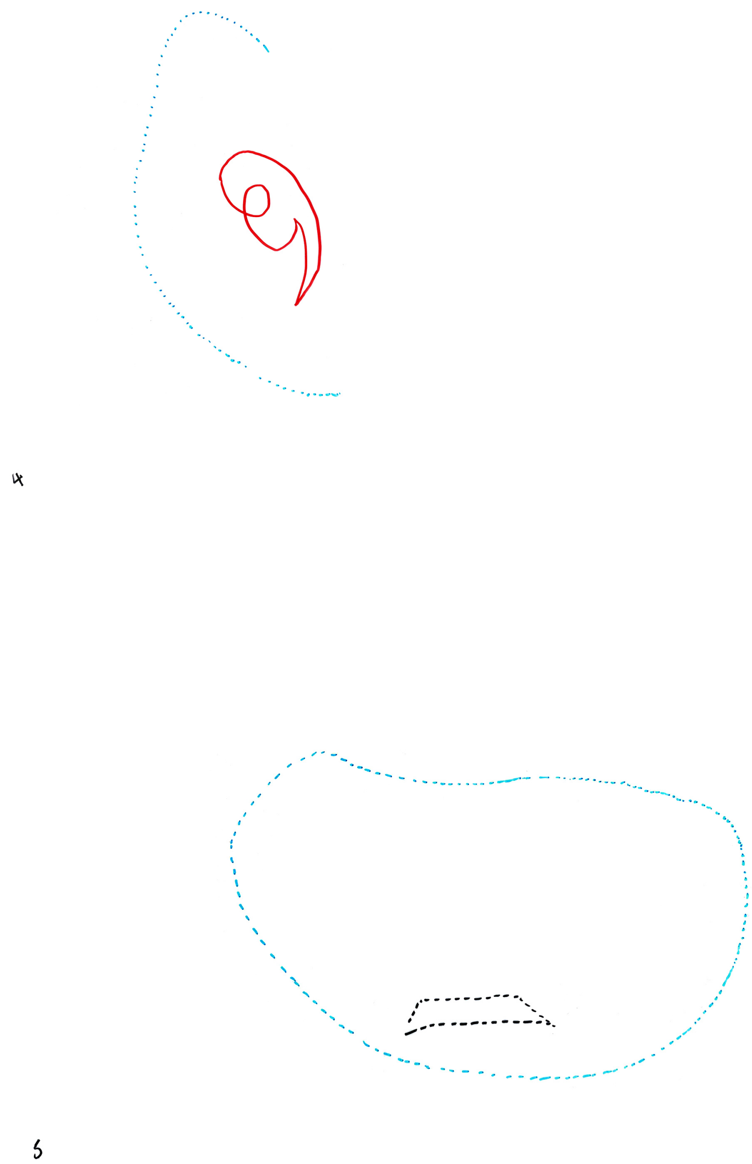


Figure 6.23: **LT, qualitative space drawings.**

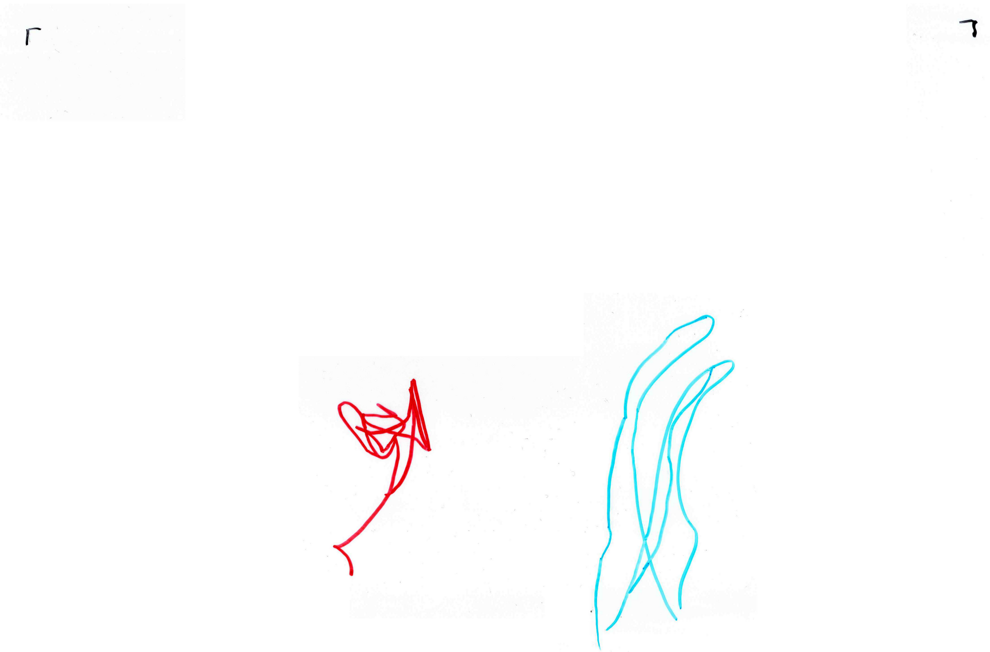


Figure 6.24: **LT, erroneous drawing.**

PB's drawings of 'telematic dinner parties' show precise fields around people and objects (food carousels and the arms placed upon tables). These are joined with much wider (physical and virtual) spaces separating the two tables drawn in light blue. This combination of constrained and wider fields produces results unique within these workshops. The size of the inscriptions relative to the people suggests a generous and necessarily expanded conception of shared space (Figs. 6.36, and 6.35).

6.5.1.12 NP

(from the COGSCI group at Queen Mary, London, female, in her 20's), made seven drawing sheets, of experimental subjects in a motion-capture studio taking part in a study of emotional empathy and gestural or postural mimicry (Fig. 6.28). The last two drawings were self-selected as being most representative of the particular interaction between the subjects (Fig. 6.30).

NP worked from paired video windows, one camera on each subject. Two camera views side-by-side, created the appearance that the subjects were not directly facing each other, but in reality they were. **NP**'s final drawing is inherently different from the others she made, in that body-parts of the subjects are represented alongside the (very nearly) closed-loop line representing the shared spaces of the interaction (Fig. 6.30). In so doing, the narrative connections between the two figures are made clearer to the viewer. The field gathers the heads, torsos, and hands of both parties into one generously drawn sphere of connection, or relationship. Its shape is dictated by hr decision to include the knees of one subject as part of the field.

NP's drawings illustrate the patterns of movement seen obliquely, from slightly above. Her earlier tracings of movement-paths contain abundant data points relating to specific body parts at different times. Path-summary boxes pinpoint where the hypothesised 'entrainment' between the pair of subjects occurred, reciprocal movements including crouching and nodding. The displacement of the information contained in these boxes is comparable to a drawing in the previous chapter (Fig. 5.6), except that here the displacement is above and below the figures,

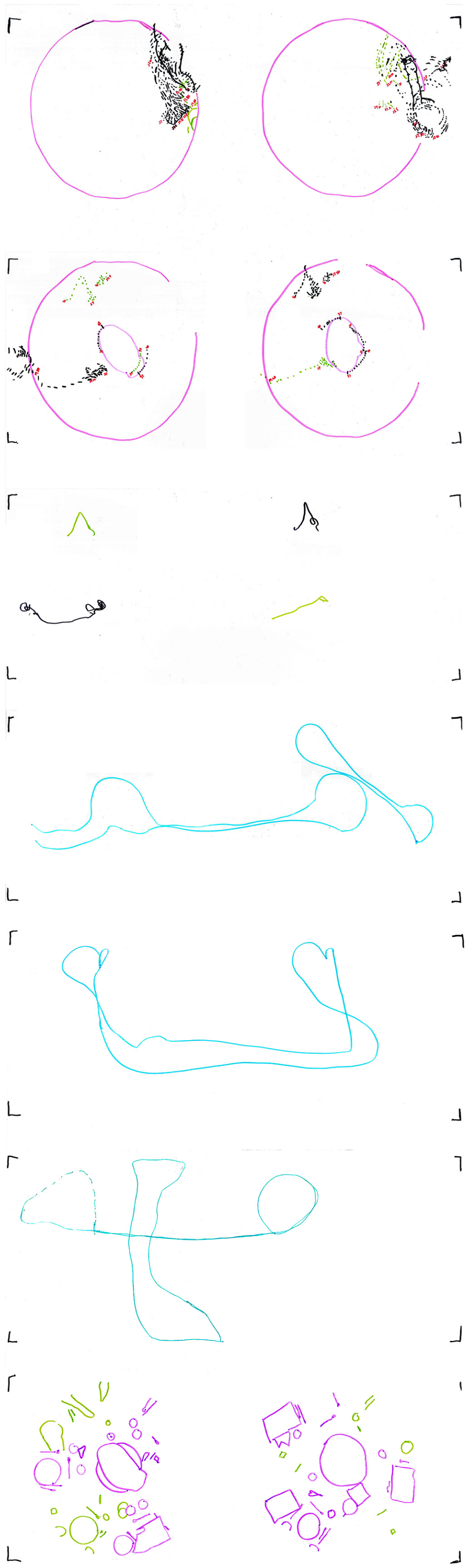


Figure 6.25: **PB, column of results.**

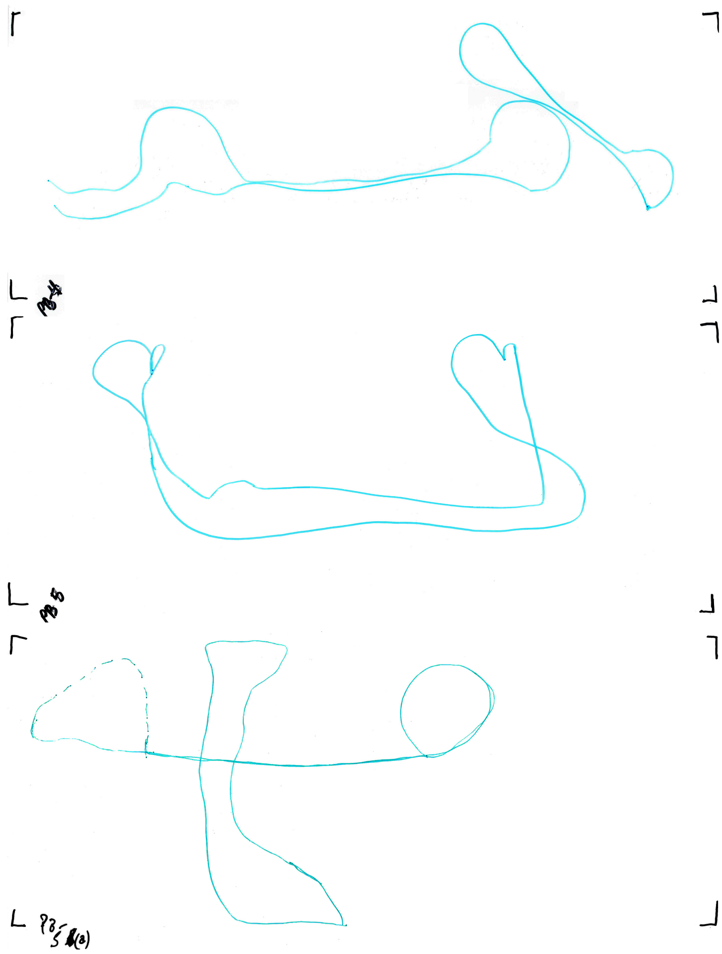


Figure 6.26: **PB, qualitative space drawings.**

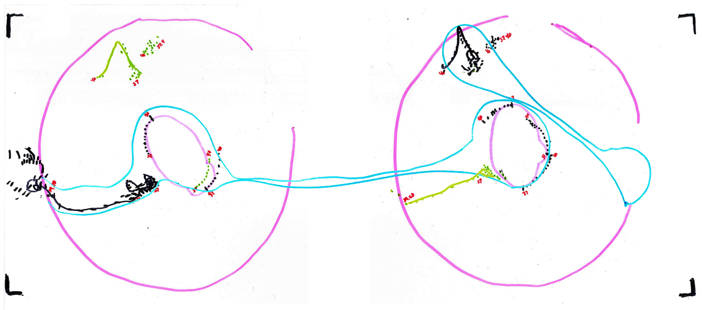


Figure 6.27: **PB, superimposed self-selected sheets 2, 3, and 4.**

making them appear slightly elongated.

6.5.1.13 ***CG***

(from the COGSCI group at Queen Mary, London, female, in her 30's), approached the drawing workshop with the intention of developing further insights into her data extracts of street performers attracting an audience in a public space. She made a total of 5 drawings (Fig. 6.31), the last 3 of which relate to qualitative spaces (Fig. 6.32).

CG firstly constructed units of the individual performer's use of space, from this building larger fields of shared and public space that she had observed in the video. These were not constrained by individual performers acting upon each other and upon the audience they were intended for. **CG**'s drawn fields can be compared, in terms of the generosity or richness of their qualitative catchment area, with other drawings made during the workshops (Sect. 6.5.1.12, Fig. 6.35).

6.5.2 Observations of Practice

This section collects together the main observations concerning how the participants worked on the tasks, as well as some of their own remarks upon the drawing process while they were doing them. The purpose is to understand how the participants saw the tasks, and how they treated the combined physical and a conceptual practice that was asked of them. Post-workshop group discussions are presented elsewhere below (Sect. 6.5.3).

Conversational exchange proved useful as a means of answering further questions on detailed matters of process, including: how to set up the registration marks on the screen (the points to align acetates to the video window), or how to scroll through the data frames at different rates. A range of other topics were also introduced by the participants.

Figure 6.28: **NP, column of drawing results.**

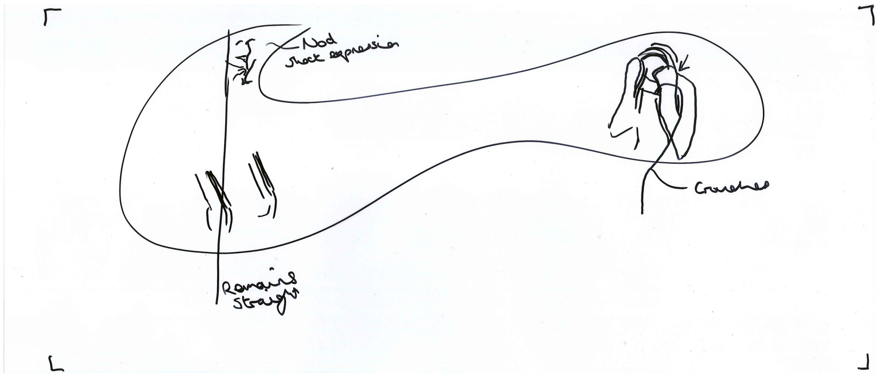


Figure 6.29: **NP, qualitative space drawings.**

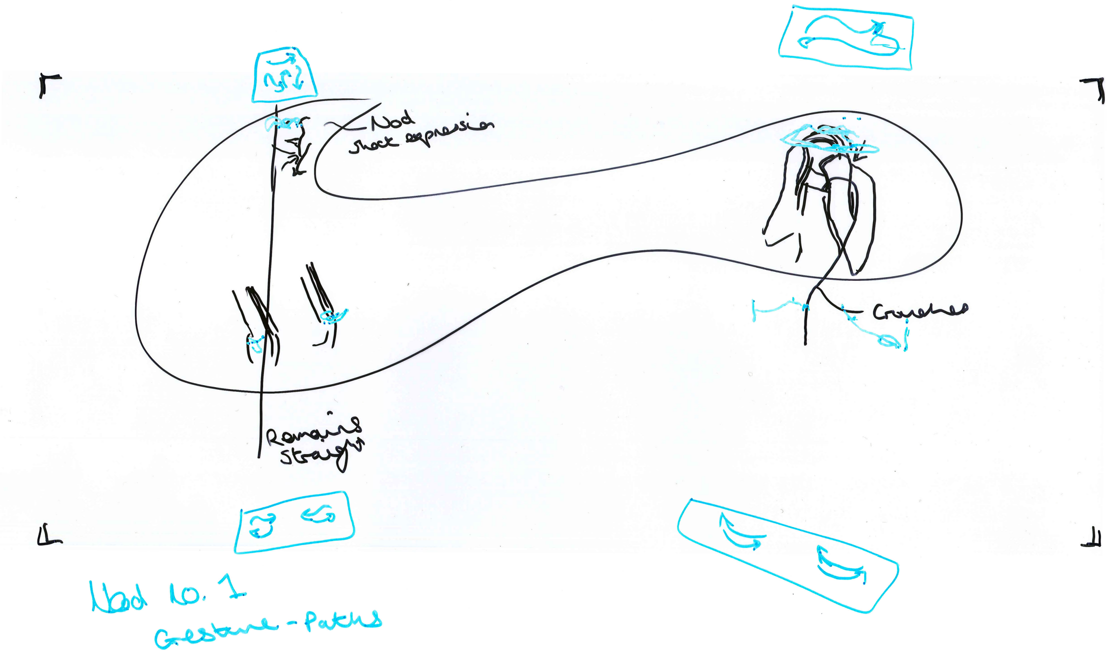


Figure 6.30: **NP, overlaid self-selected sheets.**

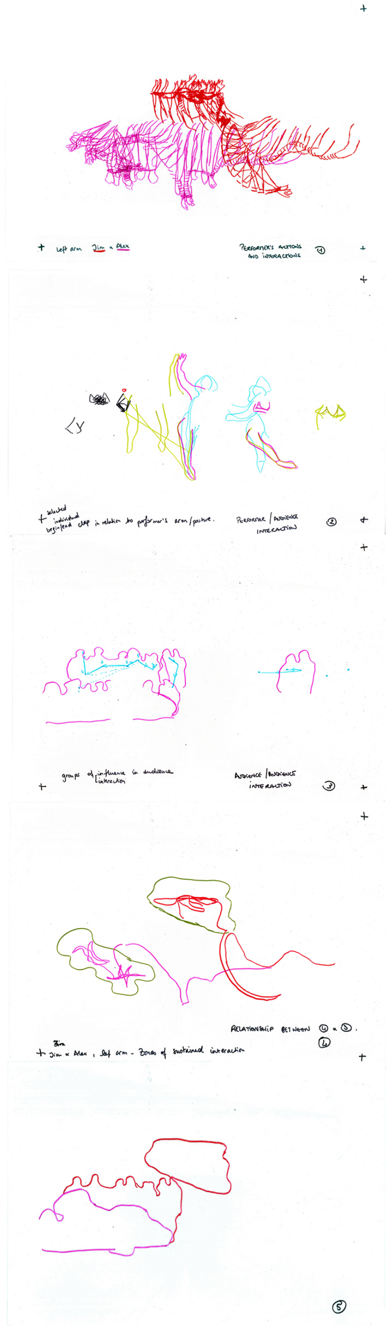


Figure 6.31: **CG, column of results.**

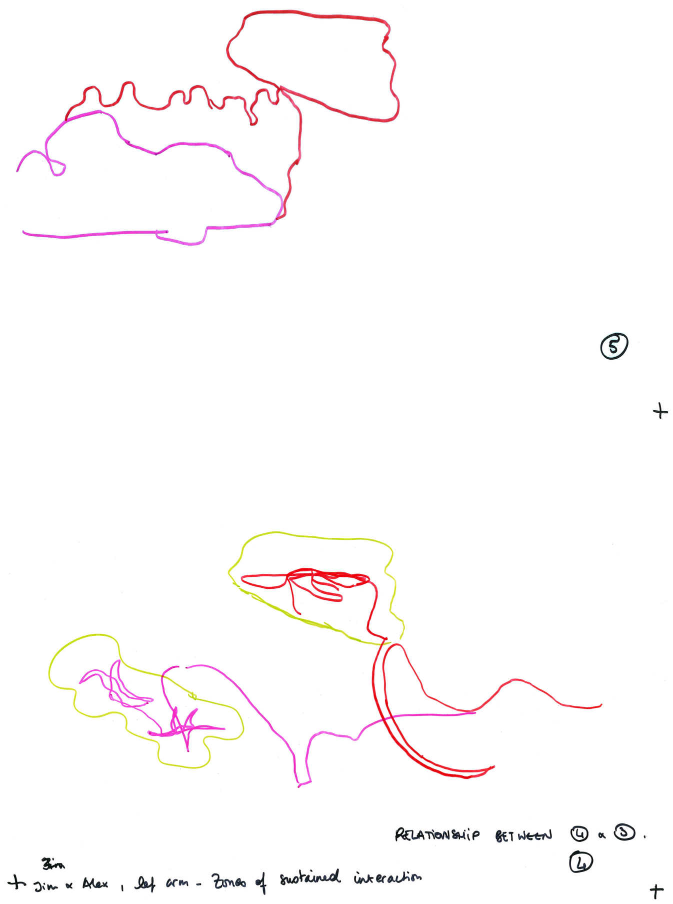


Figure 6.32: **CG, qualitative space drawings.**

Figure 6.33: **CG, superimposed self-selected sheets, numbers 3 and 4.**

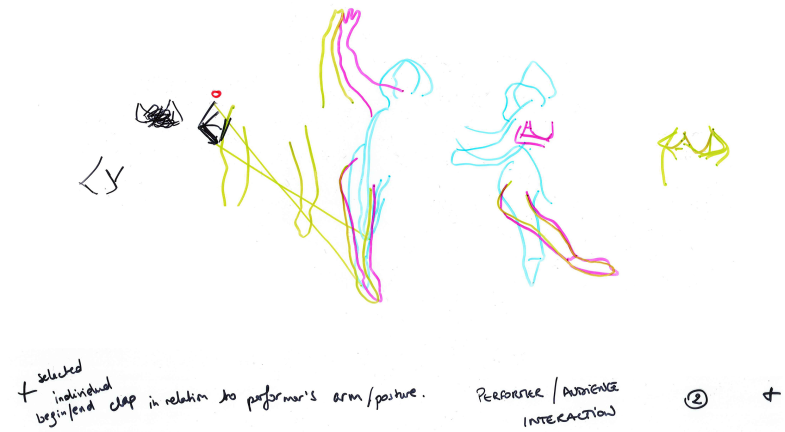


Figure 6.34: **CG, drawing 2, described as an error.**

The sections below illustrate the different stages of the operationalised procedure that was required of the participants. Significant deviations from the guidelines are also recorded here, and interpretative variations that were based upon them. It has been taken into account that politeness constraints entail that the responses to the questions (and questionnaire) from the facilitator are likely to have some degree of positive bias. This will depend on the individuals concerned, and upon their degree of familiarity with the workshop facilitator's previous research.

6.5.2.1 ***Practice: working with the guidelines***

Each participant had unique ways of progressing through the set of three tasks, and these are reflected by the sequencing of the drawings, all of which were numbered in sequence. This sequencing is illustrated by the columnar presentations of the participant's drawings that were given in the previous section (Sect. 6.5.1). These are broken down into the three stage process given in the drawing guidelines, and one example of participant's work is given for each of the guidelines in action.

The first guideline. **LT** stated that in her experience the first guideline (relating to the following of gesture-paths, Sect. 6.2.2.1), had been rewarding from the point of view of revealing or 'exposing' disparities in their fine-grain details (Sect. 6.5.1.10). **LT** also said that 'negative space' (a term transferred from life-drawing practices in fine art) could be translated into the domain of clinical psychology. This could be done by considering negatively characterised parameters for the organisation of space, and thus be potentially applicable to her research questions.

Two reactions to the outcomes of following the first guideline can be contrasted with one another. One response to the sculptural effect of collecting movements was noticed by **IB**. She remarked upon the dimensional shapes that were produced by collecting these paths, as seen in drawing 3 (see top of Fig. 6.7):

> 'they look quite interesting as a mass of marks like that.'

She had chosen to follow the outlines of whole hands across the series of video frames. This was most likely because of the desire to portray a vase-like shape that the hands were making, necessitating that more than single spots on the hands should be followed.

Another response to following his guideline, and to noticing this amassing or sculptural effect in the resulting drawings, was made by **SD**. Carefully following gesture-paths point by point through the video frames prompted **SD**'s comment during the workshop that: 'I'm not interested in hand gesture, but in coordination.' **SD** felt that the task removed her from the question that interested her, which was how to represent coordination. In this instance, for **SD** the amassing of marks produced dissonance rather than resonance.

NP chose to track single points for each of the head, hands, knees, and feet of each of her subjects. The later drawings of the series did not notate the feet, since it was apparent that there was little movement to record apart from the crouching of one subject. This selection of points allowed her to reduce her observation points to those that would contribute towards either confirming or denying the hypothesis of the study.

The second guideline. **CG**'s drawings and written comments show how the second guideline (Sect. 6.2.2.2), were closely followed and then adapted to the requirements of her data. This reflected the structure of the social spaces that she detected within her data and drawings.

The third guideline. **NP** closely followed the order and detail of the workshop instructions. Interestingly, and uniquely, her notations of movements and fields were augmented by combining them with the partial outlines of figures (Fig. 6.29). She followed the ordering of the guidelines, and only added these at the last stage to compliment the addition of the field inscriptions. These bodily outlines, were annotated with text, informing the viewer of the observed states of the experimental subjects: 'Nod / Shocked expression.'

6.5.2.2 ***Practice: Adoption of field inscription***

The second guideline. Observations on how the participants felt about the guideline and its application (Sect. 6.2.2.2). Although a majority of participants adopted field-based organisation at some point during their series of drawings, there was variation in this. Some adopted these later in the series, (**NP**), while others did so earlier on (**LT** and **PB**). A small number adopted these, but ran into obstacles preventing further progress (**IB**, and **ML**).

For example, **IB** adopted field-based drawing in her fourth drawing (of seven). In these drawings, light blues and greens are used for the second type of line described in the guidelines, aimed at notating qualitative spaces. **IB** initially constructed her representation by following the gesture-paths closely, producing a confusion of marks that are derived from hand shapes gathered from different video frames. Drawing 4 represents the field shape as if it were a sculptural form with defined edges and curved surfaces, conveying volume and transparency. The drawing sought to compare the co-speech ('community') gesture, to a 'funnel' or 'bowl' form, as she described it.

However, **IB** then found that her previous solution would not transfer so easily to the next co-speech gesture in her excerpt ('open or closed.' Drawing 6, seen below Drawing 4, in Fig. 6.7). The simultaneous movements of a pair of hands resulted in less obviously volumetric spaces, and more densely drawn loops or elliptical spaces.

Another example of how field-based marks required preparation and iteration is found in the drawings of **CG**. She had previously acknowledged that drawing 1, showing the movement paths and bodily outlines, was overloaded with marks and therefore difficult to interpret (seen at top of Fig. 6.31). Following drawings selectively reduced the amount of information that was being represented. Drawing 2, was self-described as an error, because the points on the data she followed did not ultimately contribute to grasping the relationships that were of interest to her (Fig. 6.34). This can be seen in the disjointed and fragmented appearance of the drawing, where articulating the 'performer/audience interaction' was the target. In this drawing it is difficult to unravel the temporal sequence from the ways in which different colours have been used to trace parts of the bodies at different times. This difficulty being encountered was by no means a wasted journey, since the following drawings began to comfortably utilise fields as a unit of analysis, and applied colour to their temporal organisation much more successfully (Fig. 6.32).

Hence the adoption of the technique was indeed near-ubiquitous, but far from smooth. This is to be expected when it is considered that the participants were working with data that had its own peculiarities, requiring the technique to be consciously adapted in its further use.

> **KP**: 'Drawing them in this way helps me to work out the geometry of the interactions, and especially the transition spaces where a small group opens itself out to begin to include the approaching people in the *r-space*. When I was first working out the coding, I used to print screen-shots of my simulations and calculate the angles of approach and departure from groups by using a ruler and protractor.'

KP's was a work-intensive approach to analysing data, dictated by a geometric approach to the problem space. She preferred to take the top-view perspective rather than to tackle the problems in-the-round. **KP** demonstrated a willingness for one-to-one guidance and co-production in front of the data (see the collaborative traced drawing, below, in Fig. 6.19, looking at alternative ways of organising the formations). A different version of this workshop could have actively promoted a co-design approach, working jointly towards a solution for each of the participants by pooling the abilities of participants and facilitator. **ML**, **CG**, and **IB**, would have benefitted from such an approach as well as **KP**.

*6.5.2.3 **Practice: the systematic development of insight***

NP integrated the drawing tasks and eliminated unnecessary work by compiling drawings and adding smaller diagrams in a light blue colour enclosed within same-colour boxes (Fig. 6.30). These sub-diagrams sophisticatedly separate out the sequences of movements for each of her subjects. They show movement direction, segmentation, paths, and the relationship to one another in terms of simultaneity and location of corresponding body-parts. They use arrows for each sub-segment, enabling temporal comparisons to be made between the subjects. The process of making the drawings had evidently allowed her to arrive at the following conclusion:

> 'I came with a hypothesis in mind, about finding entrainment between the two figures, and I haven't really been able to find it as I thought. But I did find some apparently reciprocal swaying.'

Discussing workflows of the workshop drawings in retrospect, **KP** said that in the earlier stages of drawing it was useful to consider groups of people projected as patterns onto the floor. She had not considered the interactional spaces needed to be visualised as multi-dimensional spaces, prior to the workshop. **KP** wished to minimise the complexity of the 3d modelling of avatar behaviours on her project, preferring to operate with top-view schemas derived from Kendon.

PB discussed the possibility that a first series of drawings could be augmented by another that included supplementary data channels: video from cameras placed at eye-level as well as the overhead views. If this was pursued there can be no doubt that a truly multi-dimensional view of shared spaces could be achieved by comparing top and side views of the same shared spaces. This relates to the proposed inscription software capable of similar operations upon video data (Sect. **??**).

SD has since gone on to merge multiple camera viewpoints into ELAN notations, enabling sophisticated synchronised overviews of interactions (Sect. 6.5.1.2). This strategy creates the opportunity to follow the emergence of shared spaces from several points of view, designing a triangulated approach to field-based inscriptions. **SD** prefers to use this technique to develop digital facsimiles of line drawings from the video stills.

6.5.2.4 ***Practice: Systematic development: Unease drawing things that cannot be seen***

SD and **SO** applied a strictly atomistic policy towards inscribing upon their data. **SD** had repeatedly expressed unease with the drawing process, especially when confronted with the observational task of identifying fields that her subjects were gesturally and posturally occupying. This music tuition session featured a music-sheet stand that partly obscured the view of the area of mutual focus (the printed score). Their pointing gestures cannot always be seen in full.

> 'I'm not comfortable with drawing things that I cannot see.'

This is due to a perception that drawing is one step removed from original data which must be adhered to as closely as possible.

SO's Drawing 3 (Fig. 6.4), followed gaze patterns, at specific points related to the dramatic sweeping gesture. **SO** had expressed hesitancy about being able to document gaze patterns, due to their rapidity and complexity. He also felt limited by the camera positioning and image resolution. Restrictions upon his angles of view of his subjects resulted in him tightened He felt that interpretation of the data was constrained by restricted camera angles, not allowing for clear views of their sight lines, and as a result his drawings referred only to physically manifested gestural and postural changes, to the exclusion of field-based inscriptions.

IB had some training in art, welcoming the opportunity to draw, finding this process of observing data to be informative about the layered semantic content of the discourse. This was primarily in relation to how co-speech gesture was competing in different spatial axes.The drawings reflect this emerging interpretation of the spatial and temporal structure of the interaction until the self-selection was reached at the end of the workshop (Fig. 6.8).

ML found it problematic to separate out the elements that would make the best items to contrast in order to elicit the sense of the interaction. This was due, she said, to the overlapping and smooth actions of each person, but she agreed that with sufficient time to develop the series of drawings it would be possible to make an adequate contrast between them. She annotated the drawing with '1' to indicate the point in time where synchronised movements begin, to show how the listener moved back in space in response.

SC's erroneous drawing shows two sketches, the first aimed at producing a form of geometric linear subdivision of the edges and shapes of the interactional spaces, which was abandoned partway. This may have been because it unduly flattens the overlapping spaces, or fails to represent deeper spaces within which gestural movements could take place (Fig. 6.17).

6.5.2.5 ***Practice: Theme: The influence of schema***

At one point, to illustrate her schema, previously established in prepared journal papers, **SD** redrew her diagram of the 'Workspace' (Fig. 6.3), describing this as:

> 'just like a bubble in front of the music stand.'

This was the space in which the teacher and the pupil engaged with one another during the class. The schema is a method of maintaining a literal overview of the data, envisaging a construct of the whole scene, despite the fact that some parts of it are obscured from camera view. **SD** and **CG** both gave overviews of their data in terms of overhead views (Sect. 6.5.1.13).

KP drew a small 'Legend' summarising her view of the qualitative spaces (Fig. 6.19), using an overhead view, as Kendon does, and all of her drawings reflect the influence of this approach. **KP** was however, in contrast to Kendon, also using perspectival views. She organised her data as a time-series, and given more time she would have been able to pursue this.

6.5.3 Post-workshop discussions

Below are a number of comments from post-workshop conversations that were conducted while looking at the drawings of each participant and at the drawings of the group as a whole.

ML said she has not done any drawing since childhood, and was nervous of the prospect. She had spent a great deal of time analysing motion-capture data involving patients interacting with non-patients. At the outset she stated that her aim was to 'refresh my position on gesture by looking at the qualitative aspects of it, rather than at the quantitative ones':

> 'The drawing process allows me to get into the detail more, and have a good look. If I was working in ELAN, I'd be confined to a certain way of working... it's really interesting to have something tangible as a result of work, rather than for it to be just stuck somewhere in the computer... I think that you need to go through the different stages to get to the more abstract shapings.'

ML subsequently acknowledged that the extent of her familiarity with current academic illustrations, may have influenced her efforts. For example, she had deliberately attempted to construct a time-series or 'small-multiple'. This is evidenced in sheet 3, where two views of the seated group are placed alongside one another, much as one would find in the literature (for example see Fig. 2.35, or 2.34). She did this at the same time as she was attempting to construct fields based upon gestural and postural coordinations (see sheet 4, left-hand side Fig. 6.9). However, when tracing over her own drawings once again, and solely concentrating on fields, there was a marked fluidity in her approach once she had been freed of the need to worry about drawing realistic figures (see drawing '4A' at the bottom of Fig. 6.9, also superimposed onto gesture-pathways in Fig. 6.10, and separated out by the facilitator in Fig. 6.13).

Discussion with **NP** during the workshop prompted her own suggestion that subsequent drawings might show the animated motion-capture data, as well as the video-capture windows that she was already using to draw from. **NP**'s familiarity with multiple views upon multi-dimensional data, is evident in her separated out drawings of gesture-paths, as is also seen in other workshops participants, (Sect. 6.5.1.7).

CG described her previous attempts to devise a visual method for recording her observations of the use of joint space, which were later abandoned due to the complexity of the procedures. This method had required hard-copies of screen-shots from interactions to be drawn upon by hand, which soon produced unmanageable 'cascade of inscriptions', to use Latour's phrase (Latour, 1986). **CG** appreciated the systematic methods of the workshop since they bypassed the specific obstacles preventing the continuation of this line of research. Observations were made by several participants that the methodical structure of the method was especially useful. (Sect. 6.5.1.11, and 6.5.1.10). **CG** said:

> 'Seeing the data this way has really helped me to develop an important aspect of it that I had put aside for pragmatic reasons, in that it would have been too much work and the wrong kind of approach, for what I needed to accomplish... so instead of looking at and isolating certain individuals who are clapping, and taking great pains to annotate the occurrence of these, I can simply take an overview and make some groupings according to what I see, without needing to make separate annotations for each person.'

This last comment suggests that she has successfully adapted the application of the guideline that recommends that the gesture-path lines be looped (*join the beginning and ends of the line*, 6.2.2).

'I didn't really know what this meant for me so I just concentrated on drawing the parts of the movements that seemed most important.' Having previously built a thorough comprehension of the details of her data extract, **CG** was keen during the workshop to construct a top-down analysis in visual form. The phrasing of the guideline was confusing for her in this respect, and she evidently found a way to translate the guideline into terms that related to her data.

The workshops were clearly fostering an increased awareness for several participants, about the relationship between the most important drawing tasks, and also of how to manage them separately. These tasks were: selection of data-points, their organisation into units of analysis, and their representation.

The pair of self-selected drawings, were said to be most representative of the segment of interaction **CG** had chosen:

> 'Drawings 3 and 4 were the most interesting to me because they show the relationship [between performers and different parts of the audience], but I had to make drawing 2, to be able to get to the point that I could isolate the connection between groups of responding audience and particular segments of the performer's actions'.

Some of **CG**'s feedback comments indicate that with further investment of resources the question of how to represent spaces that are not directly linked, and of how to incorporate temporality into these representations, can be addressed: 'Drawing 5, the last, is ok, but I prefer 3 and 4 together - except that 5 does identify the different and non-overlapping zones, and that the times are different.' In the meantime, evident progress was made towards new graphical formulations of **CG**'s research within the necessarily limited scope of the workshop.

CG spoke of 'the zone of the performer's space as it was being created', through their specific actions. For example, one of the performers executed a 'high hand' gesture, that contributed towards creating this performance-zone. The verticality of the gestural movement was an important way of bringing the attention of the audience towards the act about to follow. This was noticeable because until that moment most of the actions had been focused on creating a horizontal performance space on a public terrace.

6.5.4 Questionnaire

Below are selected responses from the questionnaires that were given to the participants following the workshops. The selection has been made on the basis of their relevance to the research questions.

6.5.4.1 ***Questionnaire: qualitative structure***

several participants spoke of the way that drawing had helped them to reorganise their interpretation of the data. **PB** stated:

> 'What's really interesting is the way in which drawing this series of connected movements allows me to organise and see the data in two different ways, because all of the previous observations I've made have been focused on writing.'

Drawing has created the possibility for a twinned approach to research, developing writing alongside a parallel visual track, and for comparisons to be made between different forms of observation.

CG stated that she had found the process of drawing informative: 'Definitely, especially in understanding the larger group interactions amongst the audience' in her video data. Importantly, she felt that 'doing it by hand might be part of the process of understanding what I am seeing in the data.' On this point, her stated preference was for direct drawing upon video rather than for specialist video annotation software requiring data to be separated into different channels.

6.5.4.2 ***Questionnaire: adoption of field inscription***

LT said 'I think it was useful to assign gestural parameters to the speakers'. Asked if negative space was a useful concept, in the context of these gestural parameters, she replied in the affirmative. The guideline (Sect. 6.2.2.2), referring to observing these empty spaces between people, was suited to the elicitation of the spatial character of the asymmetries, a central concept in her research. This requires the ability to i). identify the negative spaces, and ii). transfer the perception of a negative space into a drawn field. This response illustrates the difficulties involved in taking these steps, from seeing something as 'spatio-temporal' and vector-based, to constructing a field around these phenomena. Of all the participants, **LT** was able to construct the clearest example of a time-series (Sect. 6.22). This suggests that she had a good grasp of the events being drawn, and hence was able to easily draw a field that changed its shape over time, whether or not she was convinced of the need to inscribe this as a field in its own right.

*6.5.4.3 **Questionnaire: systematic progression***

Workshop participants were asked whether the process of drawing from their data had developed their view of it in any way. This question was aimed at understanding whether new insights into the structure of shared space had been produced by the drawing method. Responses from participants, together with their drawings, suggest that a number of them (approximately one third), had found that the workshop had led them to new formulations of thought related to the understanding of interactional spaces in their data. Some example responses to the questionnaire are presented below.

LT was asked if the workshop drawing procedure accommodated the aspects of the interaction that were of interest to her, and whether it had developed her view of the data in any way:

> 'Yes. Establishing gesture-paths in particular was a useful method for exposing disparities in the non-verbal communication of the speakers in my clip... I am particularly interested in interactional asymmetry - differential participation owed to the speakers roles, i.e. doctor/patient. I think developing a spatio-temporal understanding of this in tandem with the dialogue may be an important way to explore asymmetry in the interaction.'

LT's feedback was that using this drawing methodology might be considered in the future, and that adapting working protocols was a possibility that could arise. When asked whether bespoke software that performs similar tasks upon video data would also be considered for use, she responded that this too would be an option.

Asked in the questionnaire whether she found the drawing method was useful to her research, **PB** answered:

> 'Yes. As a visual learner and designer having a method that guides me through a deconstruction of small interactions reveals things I was not privy to before. There is something to putting a pen to the sheet and gesturing along with the processes seen in the video. I don't think I would find it as beneficial with mouse-clicks.'

PB responded productively to the physical constraints of inscribing upon video using acetate sheets over her upright screen, and she remarked on the phenomena that she noticed during this process. In response to the questionnaire she wrote:

> 'I really liked the marking on the vertical screen. It felt like painting and drawing. I leaned into the image and really looked around. I would be curious to know if it worked as well using a stylus on a pad or a mouse, connected to a vertical screen... as I worked, I became aware of other subtleties that I had not paid attention to. In particular, returning to the same frame but noticing different aspects of it.'

> 'By being able to remove all of the noise and focus on the small interactions, it was amazing the level of detail that can be achieved within the minimalist parameters.'

The act of looking at the video through their drawn marks was said to be 'revealing', expressly due to the ability to abstract to a degree and 'move away from the richness of the full video' (regarding the instruction to look for the spaces between individuals). The process of drawing from video mitigated the at times overwhelming amount of detail present, by simultaneously focusing the attention of the analysts onto certain aspects of the phenomena while distancing it from others that have been identified as less critical to the analysis of shared spaces.

6.6 Workshops: discussion of results

To reiterate upon the research questions addressed by the workshops:

1. Does the process of drawing while following these operational constraints facilitate **qualitatively structured** representations of interactional space?

2. Do the resulting drawings show adoption of **field inscription** and is this supported by the statements of the researchers?

3. Does the accumulation of working-drawings illustrate **systematic development of their visual inscriptions**?

4. Do the drawings test hypotheses about the structure of shared space against the empirical evidence of video footage?

6.6.1 The qualitative structuring of drawings

The results of the workshops show that drawing practices can facilitate qualitatively structured representations of interactional space, with the majority of participants exploring alternative ways of reconceptualising such space using the methods provided (Fig. 6.35). The variety of the approaches seen in these attempts to frame interactional space confirms that the application of the second guideline was in response to individual requirements (Sect. 6.2.2.2). Statements made by the participants show that their approach was conditioned by and adapted to the nature of their data (Sect. 6.5.3, 6.5.4.3). This was achieved in distinctive ways, as can be seen by comparing the drawings of shared spaces (Sect. 6.6.2).

Multiparty interactions are represented in spatially expansive terms, indicating that such data naturally involves a broader catchment area. Multiparty collaborative interactions resulted in larger segments of space being inscribed as shared, which could be expected given the larger scale of the groups involved (Fig. 6.33, 6.27). However, the inscriptions of the shared spaces of some dyadic interactions were comparable in terms of their size relative to the bodies of people (Fig. 6.30, 6.22).

The task guidelines specifically ask that participants restrict their work to linear inscriptions of spaces. Their drawn, written, and other responses (Fig. 6.30, and 6.18 for example) indicate that this mode of expression is sufficient for the participants to develop a range of views (from the fine-grained to the coarser) of the qualitative structure of shared space in their data. Drawings of this kind are not designed to convey the qualities themselves, but are intended to provide a non-trivial and observation-dependent framework with which to develop analytic interests. The annotations, are therefore hooks upon which analysts may, if they wish, hang further layers of qualitative description.

If a representation shows the qualitative spaces in terms of close personal space, drawn in tight relationship to the bodies of an individual subject, then this would indicate a tightly constrained field. Individual spaces may (or may not) be drawn again once they merged with those of other individuals and therefore become a representation of joint space.

6.6.2 The adoption of field inscription

Workshop drawings related to Guideline 2 are arranged according to how fields of qualitative space have been drawn, ranging from sparse to generous (Fig. 6.35). The drawings have been arranged from top to bottom, with primarily body-centric representations at the top, and distinctly shared spaces at the bottom. In between these is an intermediary category of representations that remain closely tied to the body but that are also constructed using vectors that describe interpersonal relationship.

Extraneous drawn markings have been removed and to ease the comparative process, and separate sheets of drawings have been merged into single images where necessary. The relevant human figures have been introduced in each case, thereby providing a visible physical context.

In order to construct this table, the drawings have been individually resized, so that there is an approximate uniformity in the apparent size of human bodies across all of them (the relative height and width of the head and hands have been used to obtain some constancy). This facilitates the comparison of the spaces that have been drawn, enabling the relative scope of field representations to be measured against the scale of the human body, and the distribution of the members of the group. In this way the inscriptions of fields have been arranged, in according

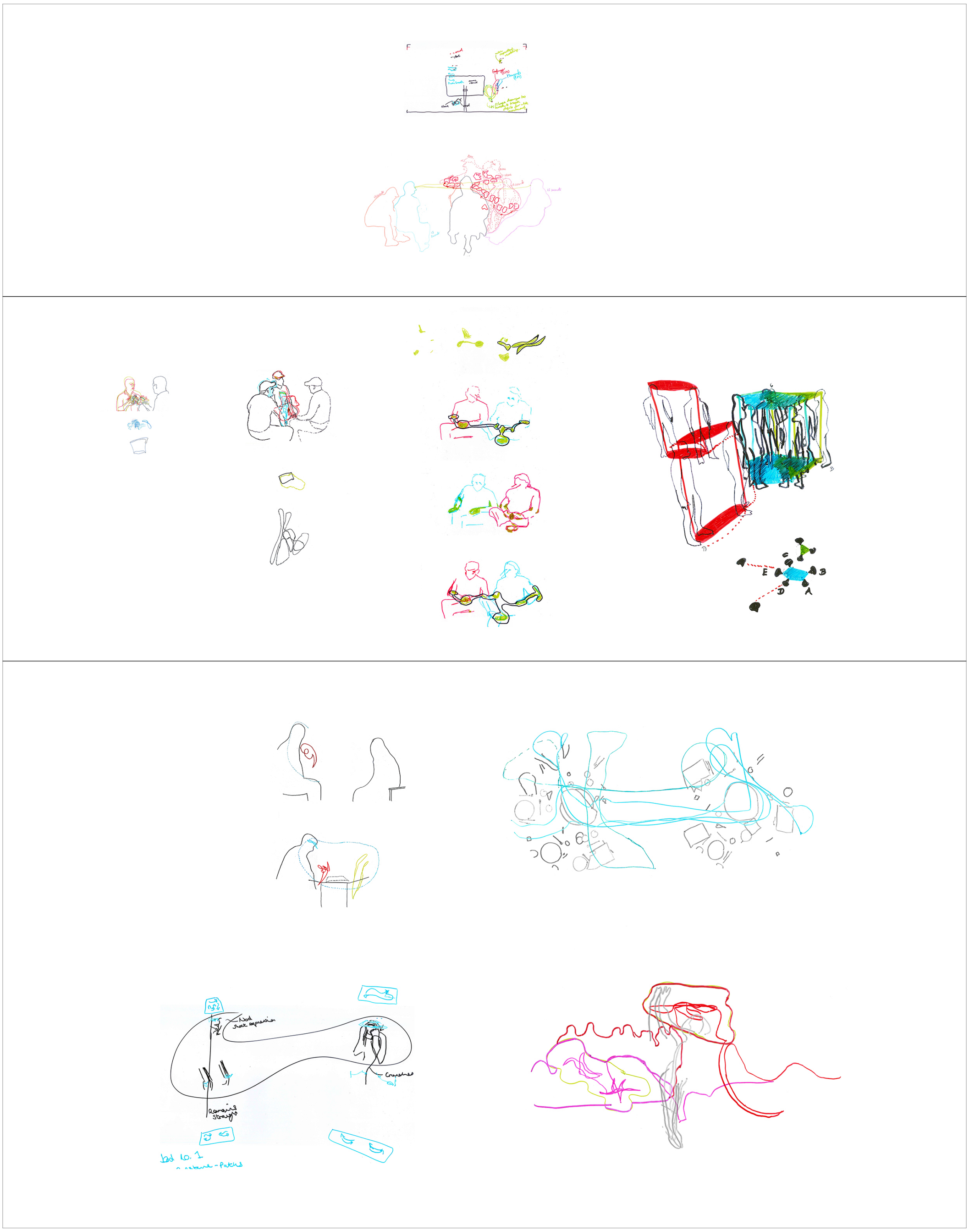


Figure 6.35: **Graphic table of results, 1: Spectra of field Inscription.**

to their relative size and the distances spanned between individuals. Larger distances have been grouped as rich or 'generous' visualisations. Smaller fields, not much more than vectors, have been grouped as 'sparse' or minimal spaces. Between these there is a category of intermediary field inscriptions, those that are neither expansive nor sparse, but in general coinciding with areas immediately around the human body.

What have been described as 'rich' representations were generated by a larger number of sheets (**LT**, **PB**, **NP**, and **CG**). These participants also drew bodily outlines less frequently, following the suggestion of the guidelines. Half of the participants followed the guidance in this way (Table. 6.1). Outlining of figures, heads, and hands, was only recommended as a final step in the drawing process (Sect. 6.2.2.3). These participants were consequently able to invest more time and effort in reconstructing precise gesture-paths, and then to construct the shapes of qualitative fields using these paths as a basis to build upon.

Table 6.1: **Workshop Results**: The adoption of field inscription. <u>Underlined</u> names are those who deferred fields until the last stage, in accordance with the provided guidelines.

Points and pathways	**SD**, **SO**
Fields of individual gesture space	**IB**, **<u>ML</u>**
Fields of shared space	**<u>SC</u>**, **KP**, **<u>LT</u>**, **<u>PB</u>**, **<u>NP</u>**, **CG**

6.6.3 The systematic development of drawings

As mentioned previously, erroneous drawings are important in establishing the development of the thought processes of participants. These drawings were described in such terms as 'this one didn't work', or 'don't pay any attention to this drawing.' For example, **CG**'s first two drawings were described retrrospectively as overloaded, and with an inappropriate visual pairing of limbs (Fig. 6.34). This shows the gradual advancement of her thinking throughout the serial production of her drawings.

Throughout the results there are examples of where the accumulation of working-drawings illustrate the organised development of visual inscriptions (Fig. 6.21 for example). All results are compared in a single table, including those drawings dismissed as errors (Fig. 6.36). The drawings of each workshop participant are shown in columns, with earliest at the top and descending in order of making. The participant columns are arranged from left to right in increasing degrees of representational 'bandwidth', or catchment area for qualitative space in this case. Drawings have not been resized, and are shown in their original proportions according to the use of the A3 acetate sheets.

The drawings often reflect an understanding of structured shared space that has been arrived at through the staged process of observing the data and drawing it. The development of this structure as fields that evolve over time is evidence for a systematic progression facilitated through drawing (Fig. 6.7, 6.11, 6.16, 6.27).

Observations of practice during the workshops reveal that a single session is an artificially compressed format within which to achieve a transformation in general approach to recording empirical observations. Participants were expected to embrace a number of techniques in a very short period of time. Despite this, however, the majority of attendees adopted field inscription as a variation of structuring social space, and encouragingly, developed upon this in their own ways.

The participants making richer or more expansive fields, produced more sheets. according to observations of their practice this was in pursuit of a deeper understanding and a broader representation of their data (Sect. 6.5.2). The level of productivity can be linked to the number of visual and analytic steps that were taken, and in the process gradually building a perspicuous

Figure 6.36: Graphic table of results, 2. Columns relate to participants, right to left: **SD**, **SO**, **IB**, **ML**, **SC**, **KP**, **CG**, **LT**, **NP**, **PB**. Please view from right side of page. Drawings in each column are ordered from top to bottom.

representation of interaction as a time-series. Within a set of practitioners largely untrained in drawing, increased productivity is one measure of increased confidence in the method. It also reflects that the method was being reapplied with reviewed aims, in the light of self-described 'errors' in drawing.

Researchers must set their spatio-temporal 'contrast-boundaries' appropriately, just as a draughts-person in a life-class (or elsewhere) must decide what it is that they are looking for and how they are going to record this on the surface before them Chamberlain et al., 2011, see Appendix. A.0.2.7). If these self-set boundaries are inappropriate to the task, a number of problems may result. Theoretically, as has been seen in the previous chapter, where the visual statement of qualitative fields is too broad then nothing of interest can be added to the structuring of space (Fig. 5.21, 6.23, can be considered as examples of this problem). In such cases, the form and specificity of a person's contribution is in danger of being lost, and the representation can easily become generic or schematic (Fig. 6.3). If the contrast-boundaries are set too narrowly, the representation becomes entirely focused upon a the bodily movements and the fine detail of gesture pathways. Although these are of interest, if presented *en masse* this will crowd out the representation of higher-level aspects of the interaction (See Figs. 6.2, plus the first drawing at the top of **CG**'s 6.31, and **NP**'s 6.28).

In other cases the degree of selectivity was well-judged. **KP** described her first drawing in response to the first guideline as a 'trial' (Fig. 6.20). Despite this dismissive description, it uses selected body parts and two colours to effectively show a formation gathering, and in so doing she merged the points of interest from the first guideline, with the bodily descriptions required by the last guideline.

6.7 Workshops: conclusions

A protocol for using the field inscriptions approach to analyse video in practice was developed and evaluated though a sequence of three participatory workshops for researchers in human interaction. The results suggest that the field-based process of drawing facilitates the production of spatially enriched graphical representations of qualitative spaces.

The workshops show that the procedure of outlining the ‘shape’ of qualitative space requires a progression through successive stages towards an openness to and recognition of field conditions, and possibly leading to a discussion of shared space (although the tasks did not specify this). Developing an ‘eye’ for how to construct such spaces requires building an appreciation of the problems involved in this practice, and a willingness to explore different solutions. Employing these techniques requires that the analyst changes their position from one of looking exclusively at data-points (movement vectors and individual body parts), to a position where sets of these are considered as larger units of analysis (fields). This gradual change of stance was described in a previous chapter (Sect. 5.3.2). Saying that one has developed an ‘eye’ for identifying and portraying these fields, is the the same thing as saying that a new analytic skill has been acquired.

6.7.0.1 ***Practices adapted: inductive methods***

The workshop results show that the drawing method is capable of a high degree of reconfiguration in the hands of individual practitioners. At the same time the results also show an overall consistency in the ways in which the guidelines produced field inscriptions, independent of considerations about the relative scale and character of those inscriptions. The workshops were aimed at testing whether this is a method that could be used to structure qualitative space, and this was clearly evidenced in the most cases. The next stage of research would be to test whether a version of this technique could be used extensively by researchers, beyond single sessions, in order to address some or all of the areas of research in human interaction that were identified as requiring further drawing and visualisation work (Sect. 2.3.2). Such drawings may also have an important role in the dissemination of research to a wider audience, potentially a rewarding area for future work.

The way in which a visual research method is introduced to researchers is crucially important, and care must be taken to describe and demonstrate the steps clearly and accessibly, and without undue prescription. A sense of ‘vertigo’ is sometimes reported in all drawing tasks, and is especially liable to occur when facing the complexities of representing human interaction. This was the reason for presenting the tasks in a concise form, using a series of steps. Tasks were consistently presented as management of small portions of their data to be traced by hand, operations adaptable to their context and easily repeatable having been grasped and performed once. Prior to the workshops a small number of participants had expressed a concern that their drawing abilities were insufficient to the task. However, by working with these guidelines very perspicuous drawings were generated, although the participants may not recognise that their drawings contained the basis for strong representations. In some cases, they may have been unused to the iterative process of drawing. The general perception of observational drawing as being difficult, is one explanation of why many researchers do not use visual research methods to make a drawn record of what they see. The methods tested here successfully managed this perception, and minimised the perceived difficulties by breaking down a larger task into smaller ones that could be operationalised.

The participant's responses may have also been constrained by the specific analytic problems that they are engaged with in their own research, and also by the nature of the analytic tools previously brought to bear upon these problems. Prior investment of time and resources may explain a natural tendency in some of the participants to extend a previously formed attitude rather than to follow a more open-ended drawing procedure (Sect. 6.5.1.2, **SD**). In other cases, the method was seized upon as a means of developing lines of enquiry that had been dropped due to the inadequacy of existing research tools (Sect. 6.5.1.13, **CG**).

The drawn solutions of workshop participants whose data related to identifiably non-metric spaces (see, **PB**, and **CG**), have a number of parallels with drawings from the previous chapter (Sect. 5.4.2). Alternate representations coincide and overlap with one another, evoking the occurrence of rapid inversions and translations of deixis and indexicality across shared spaces. This was one of the requirements identified from the literature survey (Sect. 2.3.2). Compare, for example, one participant's drawings of the space shared across two physically separated dining tables (Fig. 6.26), with exploratory drawings of the spaces that are jointly manipulated by architects (Fig. 5.15, and 5.32).

6.7.0.2 A spectrum of attitudes towards structuring qualitative space

There is a noticeable spectrum of responses to the drawing task as can be seen when these are aligned within one graphic overview (Fig. 6.35). Some participants had a tendency to see a qualitative field as being equivalent to a localised gesture pathway, and consequently the drawing method is used to track specific areas on expressive hands, fingers, and faces (Sect. 6.5.1.2). Other participants were inclined to determine a qualitative field as one that surrounds and envelops this minimal configuration, an enlargement of its scope, following but not fully determined by the paths of the physical body. Still others were comfortable with the notion that fields of qualitative space can stretch between two or more people, their inscription of the spanning space being a reflection of the way in which the interaction inflects that wider space.

The variety of this spectrum of responses is the key to addressing the identified issues from the literature survey, such as 'catchment' for example. At least four participants constructed detailed patterns of interactions over time (Sections. 6.5.1.6, to 6.5.1.12). One participant constructed a detailed drawing of discourse-patterning associated with speech (Sect. 6.5.1.5). Future work could see new versions of the drawing technique designed to capture the distinctive characteristics of this phenomena, in which case the potential diversity of mark-making may give rise to an enriched visual language. Compare the sparsest examples of representations from journals such as *Gesture*, with the variety of inscriptions for choreographed space in William Forsythe's project, *Synchronous Objects: One Flat Thing, reproduced* (Sect. 1.5.1).

Finer discriminations between these three broad categories of field inscription could very possibly be produced, with a consequent refinement of the criteria that are used to designate them. For the purposes of the present work, it is enough to note this possibility, and observe that a variety does occur, and that they inscriptions correspond with the type of phenomena that is being represented. Their superposition upon video brings them to life, and lends support to their being considered as viable visual expressions of an analyst's interpretation, just as other forms of drawing have done so in the literature Kendon, 2004, see Sect. 2.2.2.1.

The workshops were aimed at confirming, denying, or adjusting the rationale (Sect. 6.2.1). In summary, we can confirm that the guidelines for constructing field-based representations are well suited to the drawing and analytic abilities of researchers. A significant majority of the participants were able to construct fields of qualitative space, whether these were verbally accounted for in these terms or not. Qualitative spaces are not usually included in data protocols for the study of human interaction at present, and there is a lack of consistently operationalised representational techniques for this purpose, in terms of drawing or otherwise. This chapter demonstrates at least one way of introducing a measured (but non-metric) approach to inscribing shared spaces, and therefore is a prompt for these protocols to be radically revised. The survey of the literature has previously shown that drawings of shared space are an important aspect of research into human interaction (Chapter. 2), and we can now conclude that the present conventions are due for revisitation and substantial refinement.

The drawing process tested here allows many inventive, individual, and creative solutions. Future versions of this drawing technique may result in equally rich representations, possibly more so if the participatory aspect of these workshops are expanded upon. It is not easy to imagine how a digital solution to the design problem of representing shared space could be designed to achieve the infinitely variable and uniquely flexible ways in which drawing can integrate several strands of data into one image. Whether it is feasible to expect that hand-made explorations can be integrated with digital solutions, and whether this is in fact desirable, is a question that remains for future work. The challenges, means, and potential benefits of such a project will be discussed in the following chapter.

Chapter 7

Conclusion: Lines around shared space

In setting out to achieve a renewed approach to drawing human interaction, this research has had to deal with a number of issues that have presented themselves along the way. These are important questions in their own right, that have not been answered in the literature. Addressing these issues has led to a different view of what it means to draw shared qualitative space, and to represent human perspectives.

The first question related to the need to redesign the current typologies of interactional gesture, taking account of gestures that are co-produced in shared space. The survey discussed examples of where a learner completes an instructor's gesture, for example in origami-folding tasks, and in mathematical learning contexts. In these cases, completing a teacher's gesture indicates that a learner has applied new knowledge. However, the architect's meetings case-study in this thesis describes gesture-extension: where colleagues add new information into previously established topic space, using gesture and speech, thereby creating shared spaces to develop their ideas, and building a shared representation of the problem space.

Reframing present gesture typology in this way asserts shared space as a fundamental analytic category. Arising out of this is the challenge: how to track, draw, and analyse shared spaces, as seen in the architect's meetings.

Reconceptualising theoretical notions was in important part of the process of drawing the interactions. The existing analytic notion of 'catchment' was redeveloped so that it could act as a thread with which to follow the genesis of shared spaces in the architect's meetings. This involved isolating the central spatial, visual, and thematic turning points in the dialogue, narrowing the field of enquiry to just those points where space and imagery coincide, to then be jointly manipulated. The task was therefore to find a way to organise the spaces of the interaction using drawings. All of the architects become involved in this thread of catchment at different times and in different ways. Drawing these key moments required that the concept of catchment was fundamentally reinterpreted as one that partakes of and constitutes shared space. The series of symbolic visual and spatial contributions, dispersed throughout the interactions and giving them cohesion, could no longer be represented simply as the patterning of individual behaviour.

Existing representations of interactions are often body-centric depictions of the overlaps between personal gesture spaces, the proximal or distal spaces of individuals. If shared space was to be drawn as such, observable interactional criteria would have to be identified that do not depend solely on reference to the human frame, but relate to the way that participants frame spaces for one another. Through a gradual and lengthy process of drawing the same data repeatedly, and sifting through the video frames using a variety of different approaches, a focus was made upon resting hands and the consequent moulding of negative spaces, and this proved to be a way of capturing patterns of shared space. This and the particular drawing techniques that were used, drew attention to shared spaces that have previously eluded representation in drawing (or otherwise, for that matter).

One series of drawing works used the plastic surfaces of monitor screens as a surface to work on, and prepared the way for other works described elsewhere (Chap. 5). These monitors played excerpts from the architect's meetings and were incised with scalpels, each cut recording fresh encroachments on shared space (Fig. 7.2). Translating movement into cuts allowed one to see the shapes of the spaces in the middle of the groups, where contributions were being made.

In another series of preparatory studies, multi-dimensional drawings of overlapping individual gesture spaces were superimposed the speech of the architects, or sound waveforms of this speech, and were another way of seeing the shapes of the spaces in the middle of the group (Fig. 7.3). Ultimately these drawn studies were abandoned as being primarily body-centred representations of the interactions, since they were based exclusively upon overlaps between reach-space and the location of physical objects within these reaches. They did, however, show how a detailed picture of the shared spaces might look.

Figure 7.1: Scroll drawing and incised LCD screens, long view, Queen Mary, 2011.

Figure 7.2: Detail of incised LCD screen, showing film. This detail shows one architect from a group around a table. As she moves into new space, the position of her hands and arms are cut into the screen. Unambiguous sight lines between the architects are also included. Queen Mary, London, 2011.

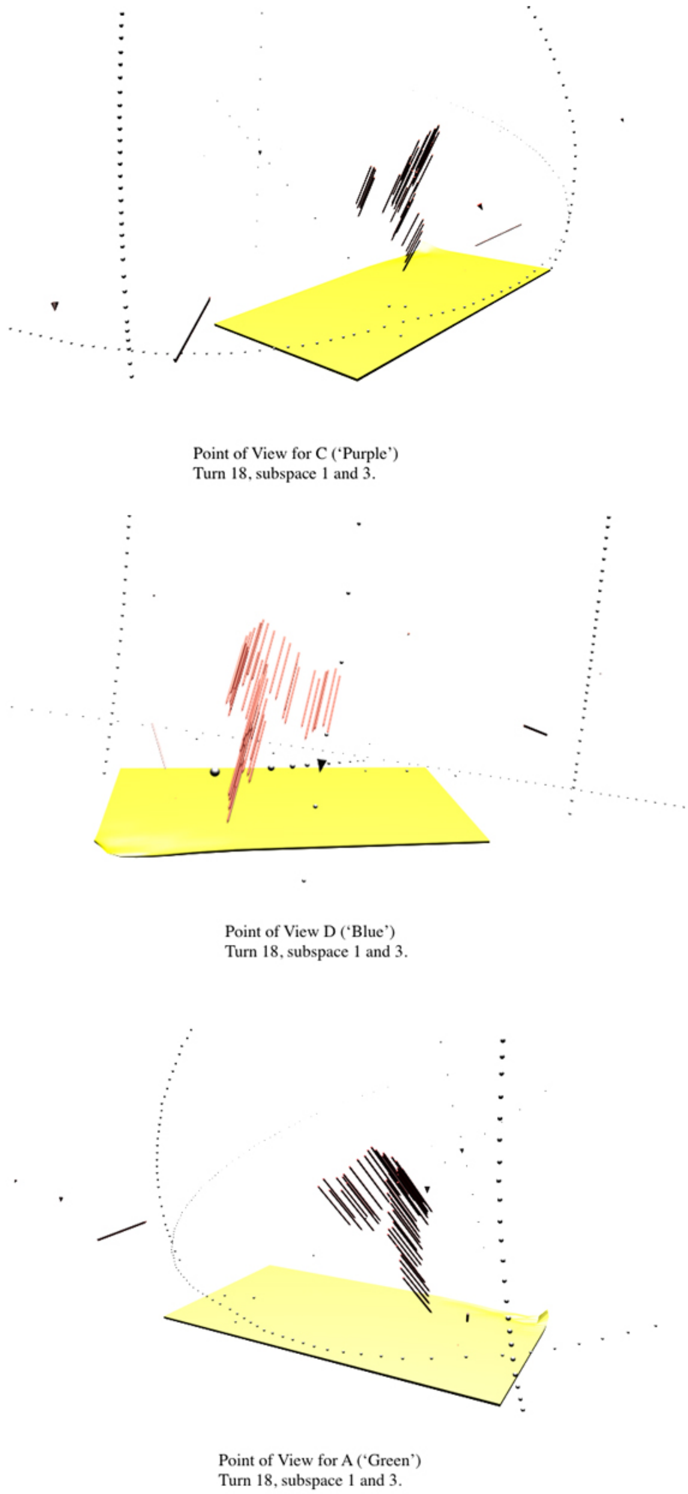


Figure 7.3: The perspectives of three of the architects (C, D, A) addressed by architect B at speech-turn 18. The perspectives are derived from approximate head positions within one iteration of the multi-dimensional sketch of the interaction. Dotted marks show where it was estimated that the outer limits of B's reach space lay.

It was only when a much older drawing approach from 2001 was revisited, towards the end of the thesis drawing research process, that a significant break from these bodily frameworks took place. At that time a series of works were made from a selection of houseplants (Kingston et al., 2003). Eucalyptus branches, for example, were drawn simultaneously on sheets of paper mounted on boards oriented in different planes and in several configurations (Fig. 7.4). The technique was designed for uninterrupted visual and tactile contact with the plants, using both hands to draw in such way that the marks were made out of sight. On one plane, one hand drew the outlines and textures of the plant stems and leaves, while the other hand drew the patterns of growth, the whorls and convolutions of leaf arrangements along the stems. Textures and patterned abstractions could be drawn on separate but related boards in a unified spatial framework, sometimes annotating the drawings with numbering and locations. Different types of marks were made for different types of sensations: for those collected by fingertips, or the whole surface of the hand, for the information presented to the eye. These were all folded together, since they were unseen at the time of making.

One outcome of this was that by attending not only to the substance of the plant but also to the spaces in, around, and between things (including 'negative spaces'), some unusual grouping and organising effects could be achieved. A drawing of 'Mexican Orange Blossom (*Choisya ternata*)', for example, contains a densely layered filigree of marks describing the plant leaves, gathered into a group by a looping red line (Fig. 7.5). Faint yellow lines outline the head of this burst of growth. This device of looping around sets of objects was carried across into the thesis-related drawings, and this in effect served to connect the present research with a long-standing interest in filtering apparently haphazard visual sensations into patterns via drawn marks. This had repeatedly appeared within art practice (Fig. 7.6).

Grouping lines around selected objects is a graphic device that researchers who have no expertise in drawing are likely to find accessible, and thus is a potentially useful one with which to organise the spaces in data. Tracing by hand onto acetates above video, and summarising observations with looped lines, is quite unlike drawing from life, and can be adopted by researchers

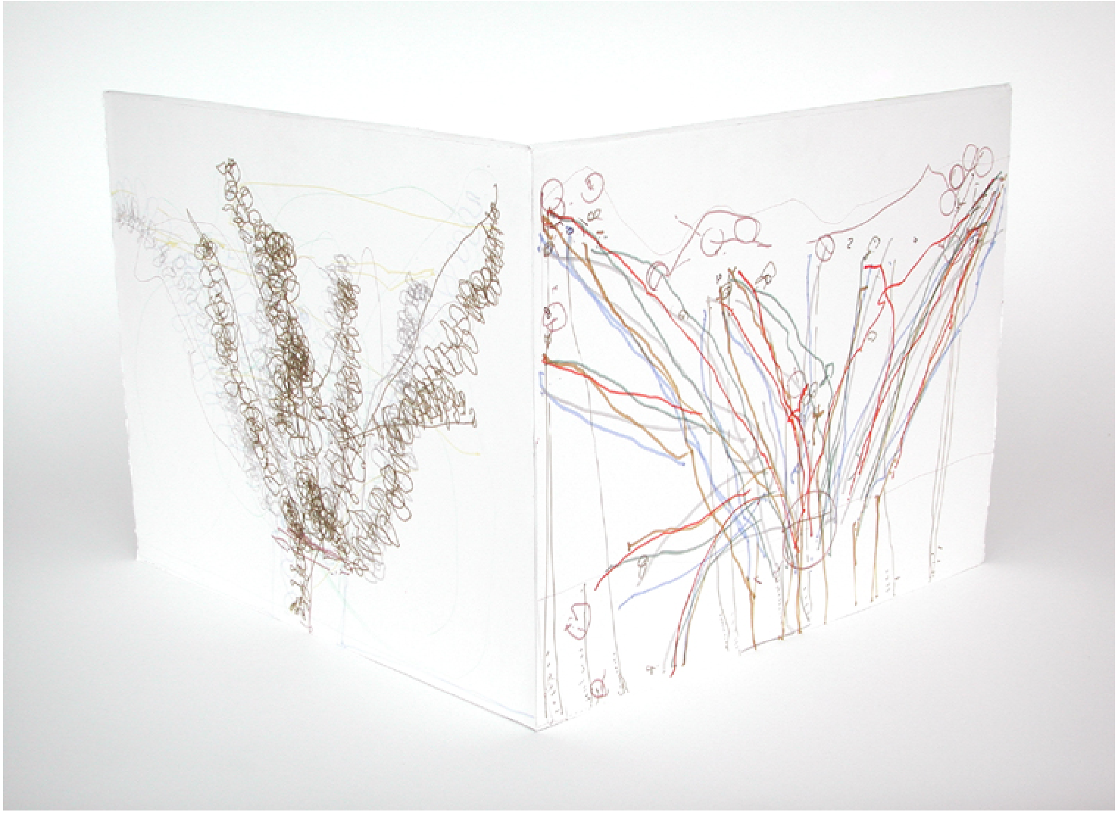


Figure 7.4: *'Eucalyptus'* Claude Heath, 2001. Acrylic ink on paper, mounted on board, on aluminium, two panels, each 45.8 x 56 cms.

with little or no training in drawing. This conspicously two-dimensional drawing technique projects the complex multi-dimensional spaces of interaction down into a manageable form. The possibility that a multi-dimensional inscriptional tool (a 3d drawing tool) might be designed for use by researchers is discussed below (Sect. 7.2.1).

7.1 What is the contribution of the visual method?

Gesture paths are usually shown as various combinations of lines or arrows, as the taxonomy of gesture representations shows (Appendix. D). The taxonomy of graphic techniques refers to the many ways that direction has been indicated, as well as speed of movement, and sequencing.

Figure 7.5: *'Mexican Orange Blossom (Choisya ternata)'* Claude Heath, 2001, detail of one area showing a looping red line around one feature of the plant. Pencil on paper. Two sheets, each 76 x 56 cms.

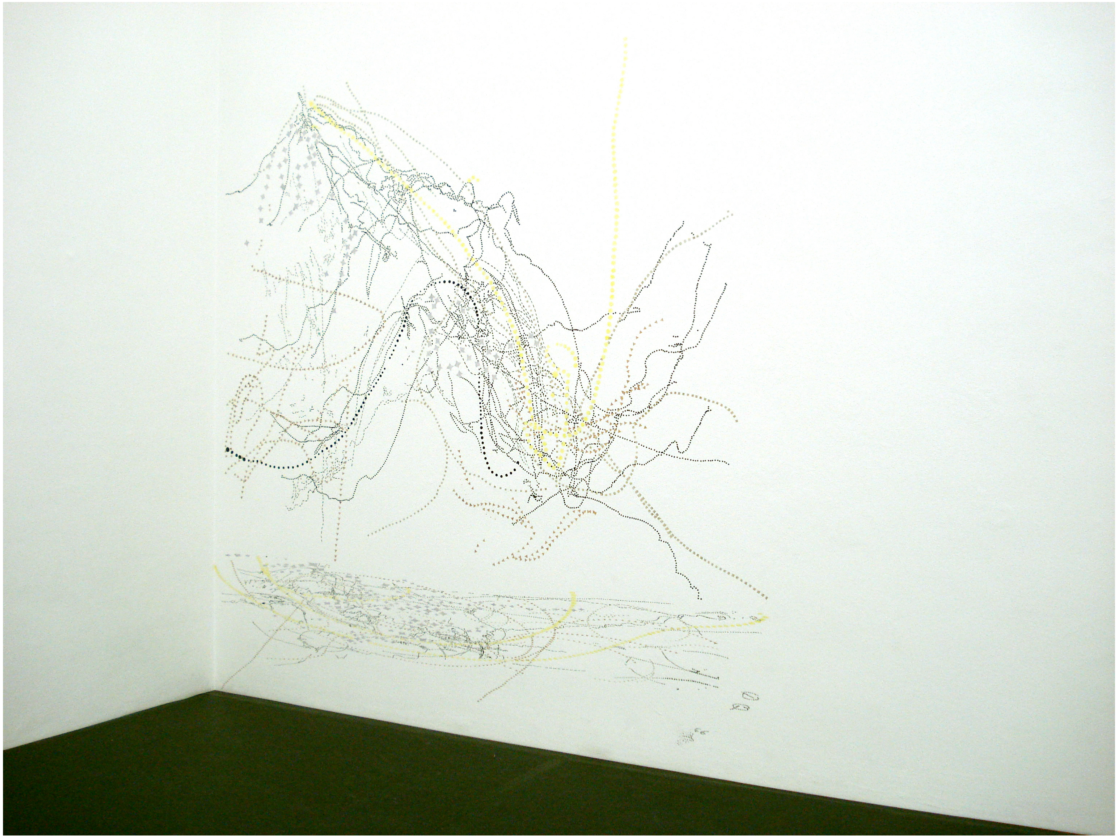


Figure 7.6: *'Ben Nevis'* Claude Heath, 2009. Wall drawing, acrylic on emulsion. Bludenz, Austria. The wall drawing is based upon drawings of stereoscopically viewed aerial photography of the mountain. The yellow lines relate to the spaces above and around the rock drawn in black.

Simply put, the contribution of the method proposed in this thesis is to take the beginning and end-points of gesture vectors and to join them up, making a single shape out of them. Part of the contribution is to provide an alternative method to communicate use of space. What results is a series of evolving and sometimes interlocking shapes that reflect the course of the conversation. The steps of this method requires the researcher to inscribe their interpretation of how shared space has been framed by participants. It is as if they must imagine that the outlines of these shapes could be cut out of paper and set against one another as volumes that are interacting with one another. This helps researchers to conceptualise the sculptural dimension of interaction, also referred to as the interactional topology (Sect. 2.2.12.1).

Gestures like the ones drawn repeatedly in this thesis are very much part of the work of the ordinary conversations, not only in the interactions of architects (whose bread-and-butter is built space), but also in any conversation that communicates and manipulates space, whether this is in the telling of a story, or giving directions in the street, for example. Without these gestures, and their use of non-metric space, people would have to find some other way to reach agreement in their conversations (perhaps by using spoken descriptions or drawings instead). It is therefore especially important to make available a method that is capable of following the sometimes simple, and sometimes intricate ways in which people use space to communicate.

Drawing as a medium of communication is particularly suited to conveying the spaces of communication. Most participants of the workshops felt comfortable to use a drawn line to represent abstract qualitative space. This may be partly due to a faithfulness the convention of diagramming scientific methods. The cognitive and social sciences (whose bread-and-butter is social space) apparently adhere to the sparse representational schemes of the 'hard' sciences, where 'non-present' qualitative entities do not fit the criteria of what may be visually represented. There is a marked absence of representations of qualitative spaces that have been tied directly to empirical observations. At this moment in time, it has been shown that human interaction researchers are open to using a line drawing method that enriches a fundamentally sparse representational paradigm (Sect. 6.7). Historically, in physics, Dirac's speculative working sketches

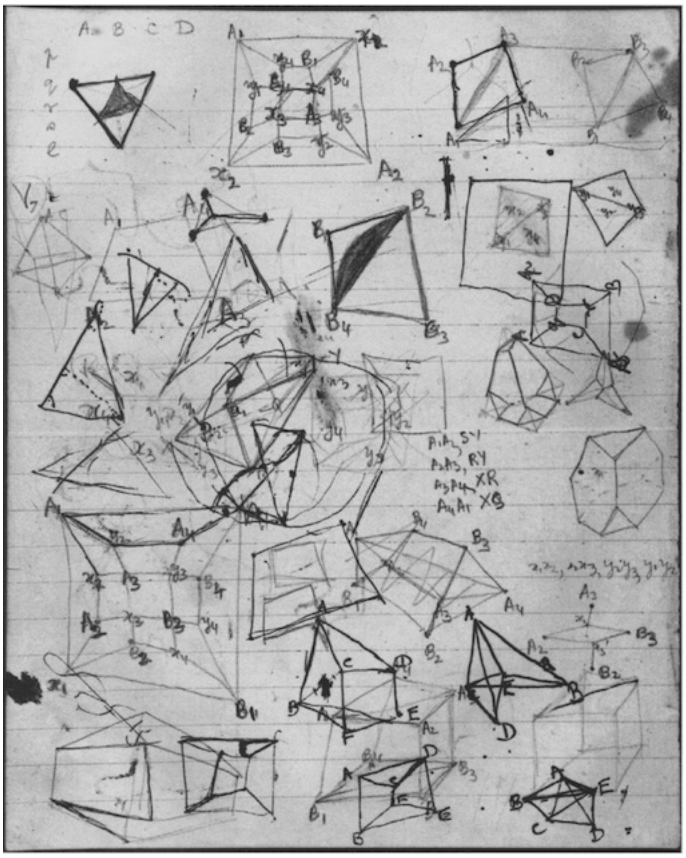


Figure 7.7: **Galison, 2000.** Paul Dirac's 'geometrical sketches.'

were self-suppressed in favour of the algebraic formulae that were expected by his specialist readership (Galison, 2000). It can be argued that an important part of the present contribution is simply to make the working sketches of human interaction research available, showing how these investigations look.

7.2 What next?

As was discussed in the survey of the literature, researchers have been reluctant or uncertain about extrapolating qualitative spaces from their ethnographic and video-based experimental data, even where there are multiple view-points from motion capture systems or from lens-based photography and film. It was also noted that this suggests that an opportunity to visualise the literal folding of interactional space is being missed. Taking the opportunity to develop the present method, in the ways discussed below, could begin the process of redressing this general state of affairs.

There are two opportunities for the development of the present research for the immediate future. The first is to design and test a digital tool for operationalising inscribed shared spaces into the video itself (rather than onto a sheet of acetate placed above it). The second is to enhance the participatory element of the drawing workshops, and thus enlarging the scope of the research. Testing the digital tool in conjunction with the innovations of analogue drawing engagements, is a promising line of development.

The parallel development of these two avenues, back-and-forth between different but complementary techniques and fields, may prove to be the critical combination. The present work has explored analogue drawing techniques in great detail, and has led to a new question: in what ways can analogue practices inform digital practices? This question concerns how researchers can define and exploit the overlap between these contrasting approaches, triangulating between different but complementary methodologies and paradigms (Sect. 1.3). A new pattern could be established, between exploratory drawings, participatory engagements, and a new component: digital prototyping.

A digital tool may extend and enrich hand-drawn explorations. One possible scenario is that a digital tool produces detailed visual filed-inscriptions of discourse, that can be viewed as video, and that can then be traced by hand that bring the attention of a reader to the specific analytic interpretation that is being offered. In this case, video containing field inscriptions would be the source for published line drawings. In another scenario, drawings made by hand would be the source for published digital inscriptions.

7.2.1 'Topic Tracer': a digital pathway.

A number of favourable comments were received from participants, in answer to the post-workshop questionnaire, where they were asked whether a digital tool capable of drawing spatio-temporal fields in interaction could be incorporated into their own research protocols (Sect. 6.5.4.3). For the sake of argument this tool is referred to as *'Topic Tracer.'*

An operationalised digital pathway should present both real and perceived 'affordances' for actions that are possible along this pathway (Norman, 2002). The interface design should yield a clear perception for the user of 'meaningful, useful action, with a known outcome', reflecting the full range possible relationships between objects and actors (Norman, 1999, p.40).

What would a digital tool accomplish that an analogue technique could not, and in what ways could this be useful? Rather than looking at this question from the standpoint of how a prototype might first appear to a user, it is advantageous to focus on how the user progresses towards a mapping of qualitative space. A walkthrough is given below, in twelve steps, although the same ends could also be achieved with different steps, and also be based upon the workshop design (Sect. 6.2) of the previous chapter:

1 The first stage, having identified which points on the video data are to be tracked, is to place a number of individual markers across the two-dimensional plane. These would be 3d points of customisable size and shape, and could be colour-coded for different people if necessary.

2 As the video is advanced (frame by frame or in motion) these markers are edited, moved by the user to follow the points of movement that they are tracking. Moving the video forwards or backwards along a time-line displays the saved markers for that moment.

3 At any stage after the markers have initially been placed, a secondary window is brought into operation on the data to add further dimensionality to the pathway. This window is used to estimate whether the markers have been placed in correct spatial position relative to one another within the scene. Looking at the original window showing the video and markers, and comparing this to the other views that contain only markers, allows the user to make adjustments to individual marker placements. The user may choose overhead or side views, and is left to decide what level of accuracy of adjustments is needed for their

data.

4 Changes made within one of these views are also effected within the other views, providing the user with a workflow that includes direct feedback as to the relative positioning of the markers that they are editing. Users who prefer to work in the original source video window, while looking at other windows only infrequently, would be able to minimise the others if desired.

5 A function is available to select markers and to save these as groups, as desired. This can be done anywhere along the video time-line, with changes taking effect throughout the video.

6 Once markers have been placed, interface slider-bars (or an equivalent form of interface control) provides the user with the ability to create volumes from the grouped markers. These controls relate to how, and to what degree, the markers are to be interpreted by the system as the cores of surrounding volumes. These take the grouped first-stage markers and surround them with another volume. Lower values would create a volume that fits closely to the original points of interest, and may have sharper contours as a result. Higher values would create a looser-fitting and rounder-edged volume.

7 A function is available to change the properties of the enveloping volumes, anywhere along the video time-line, with changes taking effect throughout the video, as controlled by the user. The visual and dimensional qualities of the volumes will be customisable by the user, and can be applied to all or a selection of these volumes, as desired.

8 Other interface controls relate to the volume-type, applying different types of visual and haptic qualities, including variations in volume boundaries, object transparency, weight, resistance to other volumes, for instance. These controls should be restricted to just those that relate to the creation of basic volumes types.

9 It should be possible to add text to saved work (perhaps a transcript of speech, and other

contextual information, or analyst comments). This function might be carried out directly onto the volumes as meta-tags.

10 Finally, there should be several ways of viewing the results, including static views of single frames. Columnar views would show the volumes of each frame displaced vertically (alternatives being horizontal, or diagonal views). These collated views would necessarily show the volumes as 'time-worms' and would require a partly automated contextualisation of the volumes. This could be achieved by including sample full video frames among the output work, as dictated by the user.

11 It should be possible to export structured video files, with separate channels for the source video and for the annotations, speech, and other text.

12 It should also be possible to export 3D files and animations, which should reflect the decisions made by the user during the above process. This function facilitates comparison between the iterations, showing how the analysis progresses.

Steps 1-4 can be compared to Guideline 1 of the workshops design ('plot the motion-paths'). Steps 6-8 can be compared to Guideline 2, concerning the construction of fields from these paths (Sect. 6.2.2). Step 5 of the digital pathway (the grouping of markers) can be seen as the bridging function between these two processes. The drawing workshop protocol accomplishes the grouping and creation of volumes in a single step (Guideline 2, Sect. 6.2.2.2). Items 9-12 of the digital pathway, given above, concern the contextualisation of the inscriptions and the transmission of the user's interpretation. This is broadly comparable to Guideline 3 of the workshops ('trace simple outlines' of the human figures).

It is relatively easy to identify points in two-dimensional video frames, and to track these. The secondary editing windows introduce a perceived affordance in how these points may be re-arranged to reflect real space. The user should be able to return to the visible points in their data, seen in the front-on view of the video camera for instance, as in Clip 1. Secondary windows are designed to qualify the view given in the video with further spatial information induced from the video. Where video data is from multiple cameras, the complexity of the user-customised interface may increase, but so too will the power of the tool to describe multi-dimensional interactional topologies. In an analogous situation, most star-charts show constellations as flat patterns, while others show stereoscopic (red-green) views of the same constellations, based upon three-dimensional satellite data (Monkhouse and Cox, 2000, Fig. 7.8).

The availability of information about estimated positioning of markers in 3d space, potentially introduces a new level of detail and rigour to hand-made drawings. Line drawings have an ability to render non-metric spaces, and this ability may be developed when utilising the outputs of the digital pathway, surpassing it on each cycle of development.

The three-dimensional capacities of the tool described here in outline, should be easily accessed if and when the user decides to make further passes through their data. To take one example, the fading of inscriptions (or 'volumes' as they have been called here) will not be automated, but will be under the control of the user. This distinguishes the present tool concept from post-production video effects, or three-dimensional editing processes, performed upon motion capture data, and visually manipulated for the purposes of public consumption (Fig. 2.21).

7.3 Theory: Following a picture

Theoretical considerations should be aimed at giving researchers the conceptual apparatus with which to balance their drawings, if that is the medium they choose, so as to 'maximally incite, but also constrain' their representations (Streeck, 2009, p. 28). Following a gesture-space schema can lead analysis in certain directions that are implied by underlying theoretical models, moving representations of data towards particular target concepts to the exclusion of others (Sect. 2.1.1.1).

Ludwig Wittgenstein warned against the philosophical temptation to follow a potentially misleading picture when thinking about certain problems (Wittgenstein, 1967, Part.1, Sections

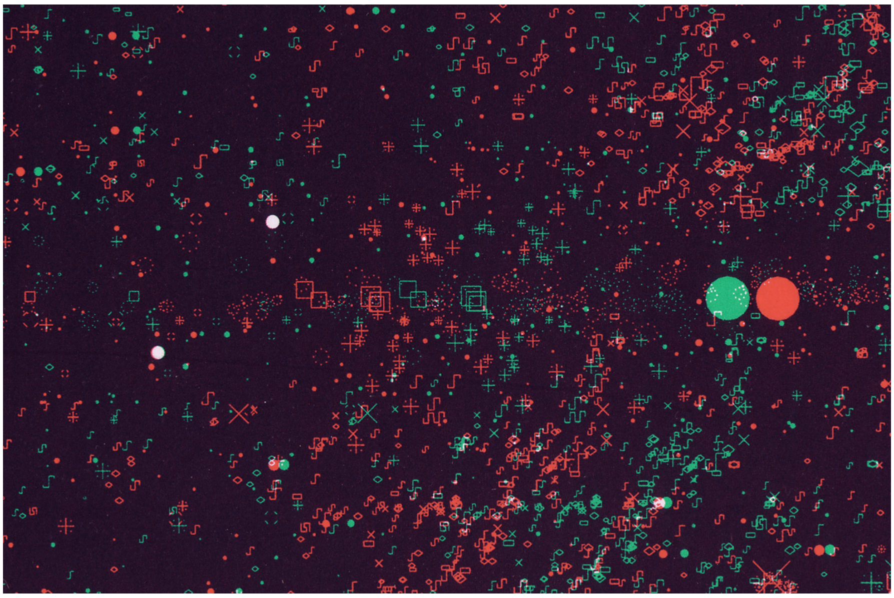


Figure 7.8: **Monkhouse and Cox, 2000.** *'The Milky Way.'* A detail of a stereoscopic map, from '3d Atlas of the Stars and Galaxies.'

172, 222, and 323). The flow of experience and language, conceived as a river flow is a metaphor that must be handled with care (Wittgenstein, 1969, Sects. 94-99). For Wittgenstein a model is an 'object of comparison' with which to bring out (or show) the connection between a world-picture and the truth or falsehood of our claims, and it is not a 'preconceived idea to which reality *must* correspond' (Wittgenstein, 1967, Sect. 131, his emphasis).

Analogies with built-in theoretical implications have cropped up throughout the literature survey. These analogies include 'gestural embroidery', the 'horizon' of a phenomenon, the topographical peaks and 'furrows' of interaction, 'ribboning' of gesture paths, 'laminating' of spaces, 'peninsulas' or 'islands' of attentional space, and the 'warp and weft' of a tapestry of discourse. In particular, gesture space has been mapped from a central bodily reference point (Efron, 1941, and McNeill, 1992), subdividing personal space as if it were a planet-like 'sphere', a domain of control surrounding the upper body, especially because of its prominent role in communication (Agamben, 2000, see Fig. 2.2).

Philosophical comparisons between the structure and flow of experience and the structure of physical space have also been made in the past, metaphorical space-time ‘video-volumes’ (Sect. 5.4.1) visible as worming shapes containing innumerable interactions: ‘Duration is the continuous progress of the past which gnaws into the future and which swells as it advances’ (Bergson, 1911, p.4-5). A ‘lived time-line’ is one that ‘grows, issuing forth from its advancing tip rather like a root or creeper that probes the earth’ (Ingold, 2007, p.118). One manuscript sketch by Wittgenstein illustrates the flow of experience: ‘the present is the sharp line in the middle, with the specious present fading off into the past on the left’ (Stern, 1991, p.588, see Fig. 7.9).

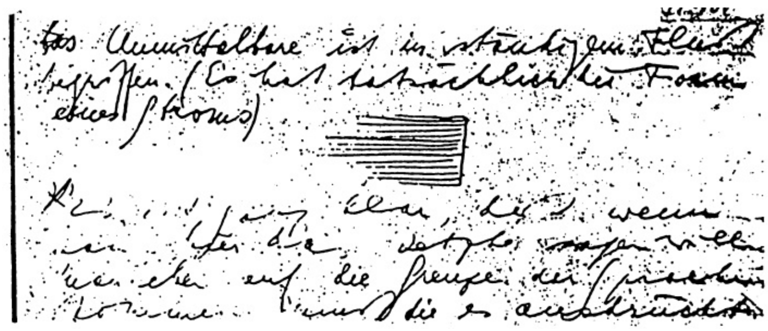


Figure 7.9: **Stern, 1991.** A manuscript sketch by Wittgenstein.

The analogy between interaction and topography, has permitted the visualisation of shared space as a transformational and non-metric landscape. This is central to the study of interaction, but ordinarily not visible, and not represented. The later drawings made for this thesis have deliberately and metaphorically treated (so-called) ‘empty’ interactional spaces as if they were physical entities, despite their abstract and non-present character. The drawings have transformed qualitative phenomena into ‘objects of comparison’ with the implied sculptural qualities of volume, relation, mass, and degrees of opacity and transparency. The shapes of inscriptions develop and disappear in response to the contours of this metaphorical interactional landscape and the changes within it. In the meantime, the aim has been to avoid the pitfalls of treating this as a model to which reality must conform, by referring to these inscriptions as explorations.

Most researchers, as we have seen, employ a variety of graphic devices to represent time in human interaction, including dotted lines for the previous or future positions of limbs, or the use of directed arrows for movement, or the superposition of video frames onto each other to show the passage of time. The drawings made on paper showing evolving topic spaces as snaking forms over the outlines of architects, can be seen as paper-prototypes for a digital tool (Fig.7.10). Computer-assisted representations of interactional fields, of the kind that would be generated by the notional 'Topic Tracer' tool discussed above, would relieve analogue representations of a significant burden of work, but also provide an opportunity for hand-made drawings to develop upon these spaces in ways that computers would find impossible.

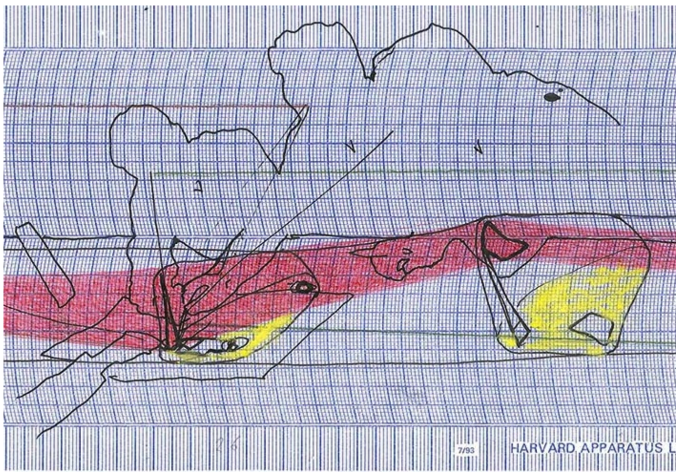


Figure 7.10: A detail of the scroll drawing, 2013.

McNeill's structural metaphor for discourse cohesion is relatively explicit, yet it does not have a significant impact on the way in which catchment is visualised, and nor does it make it easier for the reader to fully understand the implications of this abstract concept. He remarks that 'a catchment in the hydrological sense is the ground area that the water drains from, into a pond or lake' (Montredon et al., 2008, in correspondence with David McNeill, January 2003). Montredon's research group adopts 'bassin versant' (basin of land sloping in one direction) as the French equivalent of catchment in this context. None of these attributes are found in published visual material on this subject, and it seems that the structural metaphor plays itself out below the surface of his analysis.

Attempts at reconceptualising interactional and individual space have been carried out before now. Early photography saw the potential of translating temporal and spatial change into physical models which could then be compared and disseminated as outcomes of research (Fig. 7.11, and 7.12, Gilbreth, 1911). Physical presence need not imply solidity. The Italian word for comics, 'fumetti', translates as 'puff of smoke', referring to the use of word-balloons to convey speech within a frame (Cook, 2011, p. 295), a strategy which has also been used to represent human interaction analytically (Laurier, 2014). Lacan diagrammatically reshaped the topology of psychological space, using knots to represent this, as has been visualised by others with strips of folding paper (Granon-Lafont, 1985, see Fig. 7.14). Some ribbon-like drawings produced by workshop participants resemble these (see for instance the figure-of-eight shape, Fig. 6.7).

Figure 7.11: **Marey, 1887.** The flight of birds, *Volde Mouette.* Collection of Musee Marey et des Beaux-Arts, Beaune.

Drawings presented in this thesis visualise spaces of communication, revealing how 'constructing locations, is a founding and joining of spaces' (Heidegger, 1993, p.336). As Heidegger noted, the word 'perimeter' derives from the Greek *perimetros*, a compound of 'peri' (around), and 'metros' (measure). Relational 'near' and 'far' spaces refer directly to shared spaces, which by definition are jointly manufactured 'locations', and 'places'. In his example, the building of a

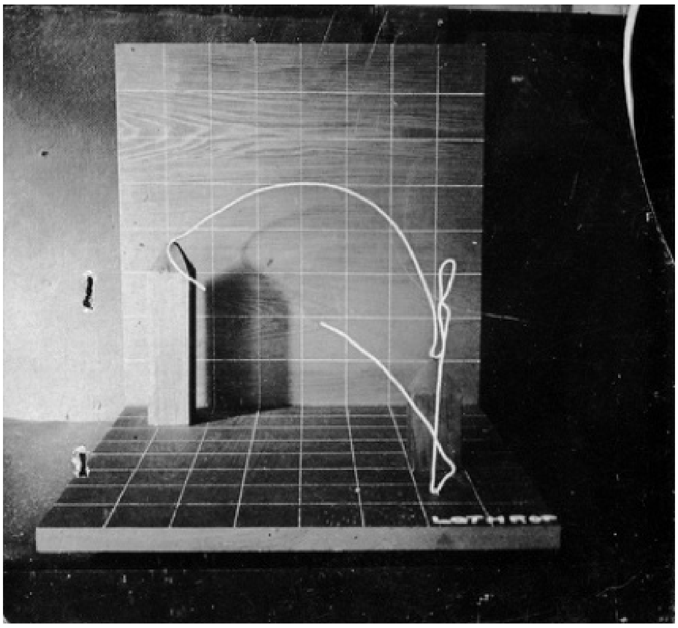


Figure 7.12: **Gilbreth, 1918.** *Motion Study.* Photographically recorded human movement translated into a wire model.

bridge brings two river banks into a relation of being 'across' from each other, one set off against the other. It also creates a neighbourhood from the joined areas of the riverbank and the land around it. The drawing methods tested here have been designed to show the this type of relation. They show the production of lived spaces (as opposed to metric spaces) as seen in data from the field, as they have been 'glimpsed in the reality' (Lefebvre and Nicholson-Smith, 1991, p.362).

Architectural plans and elevations might be said to presuppose 'an immobile perceptual field, a stable visual world' which may in fact be fractured and discontinuous (p. 361), but the drawing methods should be capable of representing interaction in either case. Just as the architects in their meetings have moulded and wrapped space to suit their current needs, so this thesis has had to create equivalents for these phenomena by looking for ways to stretch and bend the current conventions for representing human interaction. This demands 'a willingness to tolerate different, sometimes complementary and sometimes contradictory, approaches' (Jay, 1993), and this includes visual methods that reform the established conventions.

Figure 7.13: **Gilbreth, 1918.** *Motion Study.* Photographic record of task performance using spots of light positioned on limbs.

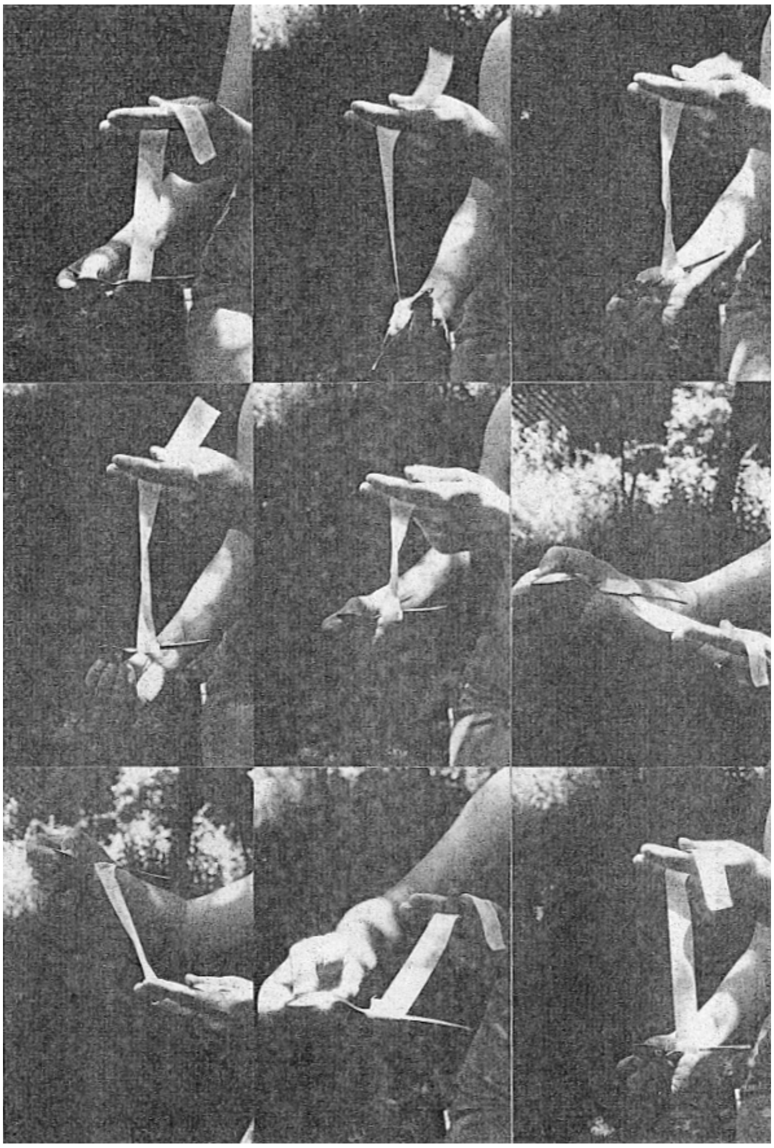


Figure 7.14: **Granon-Lafont, 1985.** *'Torsion compléte de la petite cuillére.'* Lacanian Moebius strip, from, 'La Topologie ordinaire de Jaques Lacan.'

7.3.1 Abstraction and symbolic representation

Diagrams and pictures are not articulate enough to be described as languages. Notational systems should 'identify the essential properties of a performance', and need not be complete, but should 'provide real definitions' from 'an antecedent classification of performances' according to Goodman (Goodman, 1976, p.212). Diagrams and pictures are not in the category of notational systems. Diagrams are, however, grounded in technical requirements. Topological diagrams for example, 'need only have the right number of dots or junctures connected by lines in the right pattern, the size and location of the dots and the length of the lines being irrelevant' (p. 171). Architectural models 'can be treated as diagrams' says Goodman (p. 173). The same is not true of pictures. This thesis has presented a method for creating line drawings of human interaction, designed to be read both as pictures and as diagrams, and consequently as models for seeing things differently.

Many of the drawings surveyed introduce a symbol system (of arrows, dotted lines and so forth) into diagram-like representations of human activity. We can describe these in Goodman's terms as drawings of interacting groups, line drawings that exclude 'contingencies' that are 'constitutive' of 'replete' pictures. The way in which the present and proposed symbols (field inscriptions) differ from those seen in the survey is in that they are not as 'attenuated' as other symbols (such as arrows or lines of dots). This is because they delineate regions rather than vectors, and, if the suggested drawing guidelines are followed, the inscriptions are not generalised symbols (circles, for example, that could also on the page be read as spheres). A field inscription should usually change its appearance when viewed from different perspectives. Simple circles could pass as inscriptions in the first instance, but by developing inscriptions around the observed properties of the interaction they will leave behind any form of generality and become pictorially 'replete' symbolic representations.

The method of drawing from video is motivated by the same driving force that lies behind the art practice of the present author, a desire to remain in close and in some way authentic contact with the chosen source material, and through a process of observation, to organise the experience of the material into a work. Whether this is a work of analysis or of art, depends on how the particular work in question is designed to be seen.

7.3.2 The relevance of the method

The above discussion raises the question of how field-inscriptions are to be seen and to be used. Observational drawing based upon moving or still video should appeal to those who wish to construct a detailed and organised interpretation of their data, but who do not necessarily wish to do so using a rigidly defined denotational system, where symbols have restricted applications.

Human-centred design requires due attention to the particularities of interactional topologies. The ability to picture the evolution of shared spaces provides a window through which designers can adjust the 'affordances' of specific physical settings and associated interfaces (Norman, 2002). This drawing method and potential digital tool, presents an opportunity for analysing and refining prototyped systems to make the best use of interactional topic space. For such products to succeed, much will depend on creating a tested set of 'real and perceived affordances' for user's actions. These should represent all of the possible type of relationship between objects and actors in the system. The systems design should yield the user's perception of 'meaningful, useful action, with a known outcome' that reflect the full range possible relationships between objects (Norman, 1999, p.40).

The range of data types that were drawn by the workshop participants testifies to the inherent applicability of this particular drawing method to diverse fields of research. Drawing is a tool that can be used to trace, for example, the visible differences between successful and abortive collaborative activities or all kinds, also to draw a visual comparison between constructive and obstructive psychiatric consultations to take another example (see workshops, Sects. 6.5.1.6, and 6.5.1.10). In clinical psychology settings analysts seek an understanding of patient and doctor consultations, and field inscriptions can capture reciprocating movements and other patterns of behaviour in individual and shared space, highlighting where affordances in the service design and treatments are being taken advantage of, or where opportunities are being neglected. This will apply equally to all situations where social interaction and collaborative work is facilitated through human-centred interaction design and user-experience design.

The drawing method may be used in assessing the uses of space for person-to-person and also person-to-technology relationships. Since his f-formations work, Kendon has indicated that ‘use-space’ will be a significant criterion for analysing interaction (Kendon, 2010). This suggests that the o-space may be further decomposed by being identified with other larger or smaller units of ‘use-space’, and also that there is a significant requirement felt in the discipline of human interaction for a deeper articulation of the finer structures of the o-space.

A shift away from vector-based visual representations of social space will have implications for research in human interaction, interaction design, clinical psychology, anthropology, and discourse analysis. Field-based representations add another facet to diagrammatic pictorial schemes, and can always subsume vector pathways if these are needed to express fine-grain movement within field inscriptions. This additional facet can communicate the use of space in a whole range of human interactions.

The crowd-sourcing of human interaction data, is one approach that has some potential for the collective inscription of shared spaces.[1] Using software to gather data remotely, video of human interaction can potentially be coded for fields of shared space, possibly referencing transcripts in addition. *VolumeViewer*[2] (a candidate framework for developing ‘Topic Tracer’), is suited to such purposes, where active and passive roles, and specific editing capabilities, can be assigned to different users (Palmberg and Ranlöf, 2002). This package was also used to develop a tool for analysing group gesture patterns that was discussed in the survey (Sect. 2.2.7.1, Fig. 2.47).

7.3.2.1 ***Social practices***

There is considerable promise that the drawing method will scale up from individual encounters between individuals and small groups of people, to larger units of interaction that involve the

[1] For a publicly available example see: https://www.zooniverse.org/

[2] Developer website: http://rsb.info.nih.gov/ij/plugins/volume-viewer.html

patterns of social practice observed within organisations and networks. According to Giddens, social practices are said to be enacted recursively, each enactment carries forward and maintains the enduring practice (Giddens, 1984). Individual instances of practices and the embedded rules and resources, are dispersed temporally and spatially, and may vary and evolve through the recursions. The identity of the practice persists as long as specific patterns ordered across space and time also persists. The inscription of fields of social practice lends itself to visually tracking changes within these practices, as described below.

Drawing from Wittgenstein's concept of social praxis, other writers have sought to theorise about patterns of practice. Field inscriptions are discursive symbolic representations of shared space, and if the techniques and criteria for constructing these representations are correctly adjusted, they may have a role in 'depicting the social field as a nexus of integrative and dispersed practice, and these practices as manifolds of doings and sayings linked by understandings' (Schatzki, 1996, p.222). The potential for visualisation of 'the social field' is evident, especially where drawing (and other approaches that are based on similar principles to field inscription) addresses the metamorphosing shapes and textures of 'space-time manifolds of practice' or 'fields of feasible option' (p.167).

Social practice has often been diagrammed schematically, often using metaphorical devices including ratchet mechanisms and other interlocking shapes to represent 'systems-of-systems' for instance (Fig. 7.15). These practices must somehow be represented in such a way that they are aligned with the spatial, temporal, and cultural 'regimes', and service designs, which condition the practices at a higher level (Shove, 2003). Practice-as-performance also requires articulation (Shove et al., 2012). Practices occurring within and constitutive of technologically dense environments are a special challenge.

Field inscription provides a means of seeing and analysing shared space, while also visualising the rules and conventions of practices. Graphical renderings of the spaces transforms them into a newly viable unit of analysis for the interactions:

> 'not as a patterning of presence but as an intersection of presence and absence;

underlying codes have to be inferred from surface manifestations.' (Giddens, 1984, p.16).

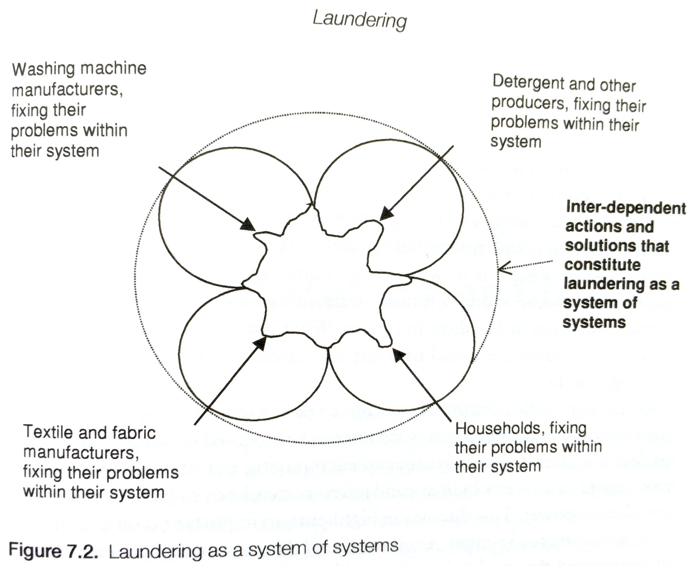


Figure 7.15: **Elisabeth Shove, 2003.** A diagram of laundering-related social and organisational practices, with an irregular field at its centre, appearing as a negative space between 'systems-of-systems.'

7.3.2.2 Rich pictures

The so-called 'soft' variables of social and organisational practices (as opposed to 'hard' technical or infrastructural variables) can be accessed using the participatory design principles of Action Research (Checkland and Holwell, 1998), the results emerging as layered 'rich pictures' (Monk and Howard, 1998). Rich pictures, physical modelling, and other forms of participatory engagement including drawing, are co-constructed and subsequently analysed with a specialised type of practical abductive reasoning (Peirce, 1998). Drawings of shared space can thus take their place alongside other materials gathered from field research and analysed as qualitative data.

It can be argued that field inscriptions of human interaction can be validated in the same way that soft system models (SSM) have to be 'internally defensible', and must be the product of a consistent process of enquiry into the world (Checkland, 1995). SSM is a methodology designed to cope with 'the kind of messy, ill-structured problematical situations with which managers of all kinds and at all levels have to cope', and to this end, 'a handful of models of purposeful activity are built,' each of which expresses a different world-view. Naming and modelling these leads to a structured debate, arriving at an 'accommodation' (p.50). Soft systems models are also 'epistemological devices' for the cyclic modelling process itself, providing a second layer of internal validation.

The drawing workshops carried out to test the drawing method, could in their next iteration benefit from participatory methods that are aimed at a collective definition of how and where field inscriptions are to be made and used. Comparable in some ways to soft system modelling, drawing workshops develop as the result of a 'cyclic learning process' (p.47). This is marked, as Checkland says, by the shift of assumed 'systemicity, from the world to the process of enquiry into the world' (p.54). The procedure is not solution-oriented, given that the nature of the design problem is 'wicked' and has no definitive formulation or stopping rule (Rittel and Webber, 1973). Nevertheless, exploring the problem can be a highly creative process: 'a recursive loop in which tentative theory fed retrospective examination of practice, that process then generating richer theory- a hermeneutic circle' (Checkland, 2005, p.286).

7.3.2.3 ***Explorations in drawing***

The drawings presented here have sometimes been described as 'exploratory', which requires some further explanation (Sect. 1.8). Contemporary art has regarded drawing as the primary vehicle for making 'a hypothesis of sight' (Derrida, 1993, p.2). Drawing is firmly rooted in the richness of 'contingencies', as Goodman called them. In the present work drawing has sought out the disparities between moving images and static representations. Hypothesising upon video data through drawing explorations has revealed 'moments of porosity or elasticity within existing structures of knowledge, taking a certain pleasure in inhabiting these perceptual or cognitive gaps', and 'its explanations remain as the line drawn in wet sand - indefinite, susceptible to change' (Cocker, 2011, p.100).

Returning to the moving image by animating the field inscriptions brings a sense of full movement and pictorial 'repleteness' (elsewhere referred to as 'life-likeness') back to the static shapes. Despite the selection of a small number of moments in the video as points of interest, moving shapes in these short animations do appear to have an internal logic and forward momentum of their own. The inscriptions may appear to be attenuated when seen individually and especially if seen without reference to human figures (see for example, Fig.5.29). This internal consistency can also be seen in drawings of interactional fields made from 'life', while watching public speakers (Fig. 7.16).

Citing Rawson (Rawson, 1987), Tormey argues for 'the purposefulness of doubt', which produces 'a vigorous conflict between a highly-developed two-dimensional surface unity, and a highly-developed three-dimensional plasticity. The higher the point to which both are developed, the stronger the drawing' (Tormey and Sawdon, 2008). Field inscriptions are simply a way of showing the viewer a clearer picture of where topical spaces lie in relation to one another, giving them a visual footprint and a presence that is easier to read on the page. The 'vigorous conflict' between two and three dimensions was noticeable in an artist's statement that was written in connection with the plant drawings mentioned earlier in this chapter:

> When you follow the movements of a football across a flat TV screen you sometimes have the sensation that the ball is going in a certain direction when it turns out to have a different arc altogether and ends up at the feet of a different player than you had first thought. Its true movements are hidden by the flatness of the screen until it arrives at some particular part of the pitch. This same kind of sensation sometimes happens while drawing, when you attempt to compress the sight and touch of a solid object onto various parts of a flat surface. (Claude Heath, artist's statement, residency at the *Centre for Drawing*, Wimbledon School of Art, 2001).

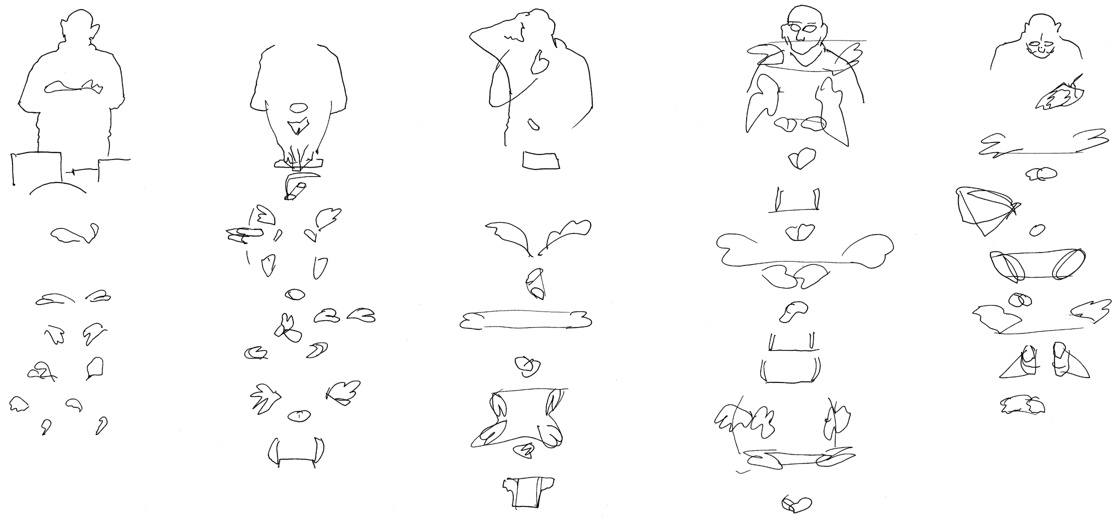


Figure 7.16: Dr. Graham White speaks at a reading group, Queen Mary, London, 2012. Pages from a sketchbook.

7.3.2.4 *Concluding note*

Why do we need to represent shared qualitative spaces? Because without a way to represent them there is no means to develop the discussion of qualitative space. Visualising shared spaces, within an analytic framework that enables it to be operationalised and transferred, makes visible what is intangible and is not ordinarily available to inspection. Researchers in human interaction should be provided with at least a visual technique with which to construct and debate the shape, distribution, and evolution of qualitative space, built upon their observations of data. This was seen in the requirements that summarised the main findings of the survey of the literature, and can also be seen from the number of phenomena that were were identified as requiring visualisation (Sect. 2.3.2).

Murphy worries that some line drawings especially are prone to lose too much of the 'material world' through their reductiveness and their focus on the figures. He says that drawings provide 'a much lower level of representational fidelity than we get from screen-grabs and other photographic images, and this can result in transcripts that are difficult to interpret' (Murphy, 2012, p. 131). This concern can be mitigated by admitting more of the material context into the drawings; but it can also be remedied by the addition of new items into the graphical architecture. It has been argued here that field-inscription is one symbolic method which results in a significantly richer picture of interaction, both theoretically and most importantly, visually.

Bibliography

Agamben, G., 2000. *Potentialities: Collected essays in philosophy*. Stanford University Press.

Allen, S., 1996. Field Conditions. *Architectural Design*, Vol. 66: pp. 21–21.

Allen, S., 1997. From Object to Field, Architecture and urbanism. *Architectural Design*, (127): pp. 24–31.

Amash, J., Nolen-Weathington, E., and Infantino, C., 2010. *Carmine Infantino: Penciler, Publisher, Provocateur*. TwoMorrows Publishing.

Badler, N. I. and Smoliar, S. W., 1979. Digital representations of human movement. *ACM Computing Surveys (CSUR)*, Vol. 11(1): pp. 19–38.

Battersby, S. A., 2011. *Moving Together: The organisation of non-verbal cues during multiparty conversation*. Ph.D. thesis, Queen Mary University of London.

Battersby, S. A., Lavelle, M., Healey, P. G., and McCabe, R., 2008. Analysing Interaction: A comparison of 2D and 3D techniques. In *Programme of the Workshop on Multimodal Corpora*. p. 73.

Bavelas, J. B., Chovil, N., Lawrie, D. A., and Wade, A., 1992. Interactive gestures. *Discourse Processes*, Vol. 15(4): pp. 469–489.

Bee, A. and Heinzelmann, M., 2004. *Gegen den Strich- Neue Formen der Zeichnung: anlässlich der Ausstellung Gegen den Strich-Neue Formen der Zeichnung in der Staatlichen Kunsthalle Baden-Baden, 17. Juli bis 26. September 2004; eine Kooperation der Staatlichen Kunsthalle Baden-Baden und des Siemens Arts Program*. Verlag für moderne Kunst.

Berg, S., Krümmel, C., and Roob, A., 2004. *Tauchfahrten: Zeichnung als reportage = Diving Trips: Drawing as reportage*. Richter Verlag.

Bergson, H., 1911. *Creative Evolution*. University Press of America.

Bermingham, A., 2000. *Learning to Draw: Studies in the cultural history of a polite and useful art*. Paul Mellon Centre for Studies in British Art.

Berti, A. and Frassinetti, F., 2000. When far becomes near: Remapping of space by tool use. *Journal of cognitive neuroscience*, Vol. 12(3): pp. 415–420.

Birdwhistell, R. L., 1952. *Introduction to Kinesics*. University of Louisville.

Boehm, G. and Cezanne, P., 1988. Montagne Saint-Victoire.

Bolden, G. B., 2003. Multiple modalities in collaborative turn sequences. *Gesture*, Vol. 3(2): pp. 187–212.

Bouissac, P., 1973. *La Mesure des Gestes*. Mouton The Hague.

Bressem, J., 2008. Notating gestures–Proposal for a form based notation system of coverbal gestures. *Unpublished manuscript*.

Bressem, J. and Ladewig, S. H., 2011. Rethinking gesture phases: Articulatory features of gestural movement? *Semiotica*, Vol. 2011(184): pp. 53–91.

Burgoyne, B., 2000. Autism and topology. *Drawing the Soul: Schemas and Models in Psychoanalysis*, Vol. 1: p. 190.

Cajal, S. R., 1910. *Manual de Histología Normal y de Técnica Micrográfica para uso de Estudiantes*. Impr. y Libr. de Nicolás Moya.

Calbris, G., 2003. From cutting an object to a clear cut analysis: Gesture as the representation of a preconceptual schema linking concrete actions to abstract notions. *Gesture*, Vol. 3(1): pp. 19–46.

Cardona, T. R., 2008. Metaphors in sign languages and in co-verbal gesturing. *Gesture*, Vol. 8(1).

Chamberlain, R., Riley, H., McManus, C., and Brunswick, N., 2011. The Perceptual Foundations of Drawing Ability. In *Thinking through drawing: practice into knowledge. Proceedings of an interdisciplinary symposium on drawing, cognition and education*. Teachers College Columbia University, pp. 95–102.

Chambers, R. et al., 1997. *Whose Reality Counts?: Putting the first last*. Intermediate Technology Publications (ITP).

Charmaz, K., 2006. *Constructing Grounded Theory: A practical guide through qualitative analysis*. Pine Forge Press.

Checkland, P., 1995. Model validation in soft systems practice. *Systems Research*, Vol. 12(1): pp. 47–54.

Checkland, P., 2005. Webs of significance: the work of Geoffrey Vickers. *Systems Research and Behavioral Science*, Vol. 22(4): pp. 285–290.

Checkland, P. and Holwell, S., 1998. Action research: its nature and validity. *Systemic Practice and Action Research*, Vol. 11(1): pp. 9–21.

Chui, K., 2012. Cross-linguistic comparison of representations of motion in language and gesture. *Gesture*, Vol. 12(1): pp. 40–61.

Ciolek, T. M. and Kendon, A., 1980. Environment and the spatial arrangement of conversational encounters. *Sociological Inquiry*, Vol. 50(3-4): pp. 237–271.

Clark, H. H., 1996. *Using Language*, Vol. 4. Cambridge University Press.

Clark, H. H., Schreuder, R., and Buttrick, S., 1983. Common ground at the understanding of demonstrative reference. *Journal of Verbal Learning and Verbal Behavior*, Vol. 22(2): pp. 245–258.

Cocker, E., 2011. Distancing the If and Then. In *Drawing a Hypothesis*. Springer, pp. 97–108.

Coecke, B. and Pavlovic, D., 2006. Quantum measurements without sums. *arXiv preprint quant-ph/0608035*.

Cohen, D. J., 2005. Look little, look often: The influence of gaze frequency on drawing accuracy. *Attention, Perception, & Psychophysics*, Vol. 67(6): pp. 997–1009.

Condon, W. S., 1980. The relation of interactional synchrony to cognitive and emotional processes. *The relationship of verbal and nonverbal communication*: pp. 49–65.

Condon, W. S. and Sander, L. W., 1974. Neonate movement is synchronized with adult speech: Interactional participation and language acquisition. *Science*.

Cook, R. T., 2011. Do Comics Require Pictures? Or Why Batman# 663 Is a Comic. *The Journal of Aesthetics and Art Criticism*, Vol. 69(3): pp. 285–296.

Craig-Martin, M. and Martin, M. C., 1995. *Drawing the Line: Reappraising drawing past and present*. South Bank Centre, London.

Creswell, J. W., 2013. *Research Design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Crystal, D., 1987. *The Encyclopedia of Language*. Cambridge University Press.

Cutting, J. E., 2002. Representing motion in a static image: constraints and parallels in art, science, and popular culture. *Perception*, Vol. 31(10): pp. 1165–1194.

Da Vinci, L. and MacCurdy, E., 1957. *The Notebooks of Leonardo da Vinci*. Modern Library.

Damisch, H., 2002. *A Theory of/Cloud/: Toward a History of Painting*. Stanford University Press.

Davis, M., 2001. Film Projectors as Microscopes: Ray L. Birdwhistell and microanalysis of interaction (1955-1975). *Visual Anthropology Review*, Vol. 17(2): pp. 39–49.

de Bruyn, D., 2007. Performing a Traumatic Effect: The Films of Robert Breer. *Animation Studies- Animated Dialogues*: pp. 20–28.

Delaporte, Y. and Shaw, E., 2009. Gesture and signs through history. *Gesture*, Vol. 9(1): pp. 35–60.

Denzin, N. K. and Lincoln, Y. S., 2005. *The Sage Handbook of Qualitative Research*. Sage Publications.

Derrida, J., 1993. *Memoirs of the Blind: The self-portrait and other ruins*. University of Chicago Press Chicago with Musée du Louvre.

Dima, M., Lee, J., Wright, M., Ullattil, A., and Cao, X., 2009. Designing a haptically extended interface for digitally animating 3D articulated characters. In *Proceedings of the 2009 international conference on Electronic Visualisation and the Arts*. British Computer Society, pp. 221–228.

Dubery, F. and Willats, J., 1972. *Drawing Systems*. Studio Vista, London.

Dutsch, D., 2007. Gestures in the manuscripts of Terence and late revivals of literary drama. *Gesture*, Vol. 7(1): pp. 39–71.

Efron, D., 1941. *Gesture and Environment: A tentative study of some of the spatio-temporal and "linguistic" aspects of the gestural behavior of eastern Jews and southern Italians in New York city, living under similar as well as different environmental conditions*. King's Crown Press.

Emmorey, K. and Reilly, J. S., 1995. *Language, Gesture, and Space*. Lawrence Erlbaum Associates Hillsdale, NJ.

Forsythe, W., 2008. Choreographic Objects. *William Forsythe: Suspense*.

Fricke, E., 2003. Origo, pointing, and conceptualization- what gestures reveal about the nature of the origo in face-to-face interaction. *Pragmatics and Beyond, New Series*: pp. 69–94.

Frishberg, N. and Gough, B., 1973. Time on our Hands. *Unpublished manuscript, University of California at San Diego*.

Furuyama, N., 2000. Gestural interaction between the instructor and the learner in origami instruction. *Language and gesture*, Vol. 99.

Furuyama, N., 2002. Prolegomena of a theory of between-person coordination of speech and gesture. *International Journal of Human-Computer Studies*, Vol. 57(4): pp. 347–374.

Galison, P., 2000. The suppressed drawing: Paul Dirac's hidden geometry. *Representations*: pp. 145–166.

Garcia-Lopez, P., Garcia-Marin, V., and Freire, M., 2010. The histological slides and drawings of Cajal. *Frontiers in neuroanatomy*, Vol. 4.

Gerofsky, S., 2010. Mathematical learning and gesture: Character viewpoint and observer viewpoint in students gestured graphs of functions. *Gesture*, Vol. 10(2-3): pp. 2–3.

Giddens, A., 1984. The constitution of society: Outline of the theory of structuration. *Polity*.

Gilbreth, F. B., 1911. *Motion Study: A method for increasing the efficiency of the workman*. D. Van Nostrand.

Gill, S. P., 2008. *Cognition, Communication and Interaction: transdisciplinary perspectives on interactive technology*. Springer.

Ginzburg, J., 1996. Interrogatives: Questions, facts and dialogue. *The Handbook of Contemporary Semantic Theory*.

Gonzales, P., Jacoby, S., and Ochs, E., 1994. Interpretive journeys: How physicists talk and travel through graphic space. *Configurations*, Vol. 2(1): pp. 151–171.

Goodman, N., 1976. *Languages of Art: An approach to a theory of symbols*. Hackett Publishing.

Goodwin, C., 2000. Gesture, aphasia, and interaction. *Language and gesture*, Vol. 2:p. 84.

Goresky, M. and MacPherson, R., 1988. *Stratified Morse Theory*. Springer.

Granon-Lafont, J., 1985. *La Topologie Ordinaire de Jacques Lacan*. Editions Point Hors Ligne.

Haviland, J., 1996. Projections, transpositions, and relativity. *Rethinking linguistic relativity*, Vol. 17:p. 271.

Haviland, J. B., 2000. Pointing, gesture spaces, and mental maps. *Language and Gesture*, Vol. 2:p. 13.

Haviland, J. B., 2005. Directional precision in Zinacantec deictic gestures: (cognitive?) preconditions of talk about space. *Intellectica*, Vol. 41: pp. 25–54.

Healey, P. G. and Battersby, S. A., 2009. The interactional geometry of a three-way conversation. In *Proceedings of the 31st annual conference of the cognitive science society*. pp. 785–790.

Healey, P. G. and Peters, C. R., 2007. The conversational organisation of drawing. In *Pen-Based Learning Technologies, 2007. PLT 2007. First International Workshop on*. IEEE, pp. 1–6.

Heath, C., 2011. Unsighted tactile drawings of prehistoric archaeological objects. *Interventions: Măgura Past and Present*:p. 185.

Heath, C. and Taylor, D., 1999. *Claude Heath Drawing from Sculpture*. Henry Moore Sculpture Trust, Henry Moore Institute.

Heath, C. P., Cameron, L., and Cain, P., 2008. The Practice of Three-Dimensional Drawing. Leeds University Department of Computing.

Heath, C. P. and Healey, P. G. T., 2011. Making space for interaction: architect's design dialogues. In *Proceedings of the 9th International Gesture Workshop*.

Heidegger, M., 1993. *Basic Writings: Revised and expanded*. Harper One.

Hicks, D. A., 1994. Individual and social meanings in the classroom: Narrative discourse as a boundary phenomenon. *Journal of Narrative & Life History*.

Holmes, N. P. and Spence, C., 2004. The body schema and multisensory representation(s) of peripersonal space. *Cognitive Processing*, Vol. 5(2): pp. 94–105.

Holty, C., 1957. Mondrian in New York: a memoir. In *Arts*, Vol. 31. pp. 17–21.

Howard, S., 1985. The steel pen and the modern line of beauty. *Technology and Culture*: pp. 785–798.

Ingold, T., 2007. *Lines: A brief history*. Routledge, London.

Jay, M., 1993. *Downcast Eyes: The denigration of vision in twentieth-century French thought*. University of California Press.

Katsushika, H. and Smith, H. D., 1988. *One Hundred Views of Mt. Fuji*. George Braziller.

Kendon, A., 1976. The F-formation system: The spatial organisation of social encounters. *Man-Environment Systems*, Vol. 6: pp. 291–296.

Kendon, A., 1990. *Conducting Interaction: Patterns of behaviour in focused encounters*, Vol. 7. Cambridge University Press.

Kendon, A., 2004. *Gesture: Visible action as utterance*. Cambridge University Press.

Kendon, A., 2010. Spacing and orientation in co-present interaction. In *Development of Multimodal Interfaces: Active Listening and Synchrony*. Springer, pp. 1–15.

Kimbara, I., 2006. On gestural mimicry. *Gesture*, Vol. 6(1): pp. 39–61.

Kingston, A., 2001. The Centre for Drawing: The First Year. *Wimbledon School of Art, London*.

Kingston, A., Ginsborg, M., Patrizio, A., Amore, I., Barlett, N., and Naginski, E., 2003. *What Is Drawing?* Black Dog, London.

Klima, E. S. and Bellugi, U., 1979. *The Signs of Language*. Harvard University Press.

Koschmann, T., LeBaron, C., Goodwin, C., Zemel, A., and Dunnington, G., 2007. Formulating the triangle of doom. *Gesture*, Vol. 7(1): pp. 97–118.

Kozbelt, A., 2001. Artists as experts in visual cognition. *Visual Cognition*, Vol. 8(6): pp. 705–723.

Kubat, R., DeCamp, P., Roy, B., and Roy, D., 2007. Totalrecall: visualization and semi-automatic annotation of very large audio-visual corpora. In *ICMI*, Vol. 7. pp. 208–215.

Ladewig, S. H., 2011. Putting the cyclic gesture on a cognitive basis. *CogniTextes. Revue de l'Association française de linguistique cognitive*, Vol. 6.

Latour, B., 1986. Visualization and cognition. *Knowledge and Society*, Vol. 6: pp. 1–40.

Laurier, E., 2014. The Graphic Transcript: Poaching Comic Book Grammar for Inscribing the Visual, Spatial and Temporal Aspects of Action. *Geography Compass*, Vol. 8(4): pp. 235–248.

Law, J., 2004. *After Method: Mess in social science research*. Routledge, London.

Lefebvre, H. and Nicholson-Smith, D., 1991. *The Production of Space*. Basil Blackwell, Oxford.

Lewin, K. and Cartwright, D., 1952. *Field Theory in Social Science: Selected theoretical papers*. Tavistock, London.

Liddell, S. K., 2000. 16 Blended spaces and deixis in sign language discourse. *Language and gesture*, Vol. 2: p. 331.

Light, A., 2006. Adding method to meaning: a technique for exploring peoples' experience with technology. *Behaviour & Information Technology*, Vol. 25(2): pp. 175–187.

Lucas, R., 2009. Inscribing the city: a flâneur in Tokyo. *Anthropology Matters*, vol. 6(1).

Mallery, G., 1881. *Sign Language Among North American Indians: Compared with that Among Other Peoples and Deaf-mutes*, vol. 14. Mouton.

Marchand, T. H., 2010. Embodied cognition and communication: studies with British fine woodworkers. *Journal of the Royal Anthropological Institute*, vol. 16: pp. S100–S120.

Markard, A. and Guest, A. H., 2003. Kurt Jooss-The Green Table: The Labanotation Score, Text, Photographs, and Music.

Martell, C., 2005. *FORM: An experiment in the annotation of the kinematics of gesture*. Ph.D. thesis, University of Pennsylvania.

Maslen, M. and Southern, J., 2011. Drawing Projects-An Exploration of the Language of Drawing.

McCloud, S., 1994. *Understanding Comics*. William Morrow Paperbacks.

McNeill, D., 1992. *Hand and Mind: What gestures reveal about thought*. University of Chicago Press.

McNeill, D., 2005. *Gesture and thought*. University of Chicago Press.

McNeill, D., 2008. Gestures of Power and the Power of Gestures. *University of Chicago*.

McNeill, D., Duncan, S. D., Cassell, J., and Levy, E. T., 2007. *Gesture and the Dynamic Dimension of Language: Essays in honor of David McNeill*, vol. 1. John Benjamins Publishing Company.

McNeill, D. and Pedelty, L. L., 1995. *Right Brain and Gesture*. Lawrence Erlbaum Associates.

McNeill, D., Quek, F., McCullough, K.-E., Duncan, S., Furuyama, N., Bryll, R., Ma, X.-F., and Ansari, R., 2001. Catchments, prosody and discourse. *Gesture*, Vol. 1(1): pp. 9–33.

Monk, A. and Howard, S., 1998. Methods & tools: the rich picture: a tool for reasoning about work context. *interactions*, Vol. 5(2): pp. 21–30.

Monkhouse, R. and Cox, J., 2000. *3-D Atlas of Stars and Galaxies*. Springer, London.

Montredon, J., Amrani, A., Benoit-Barnet, M.-P., You, E. C., Llorca, R., and Peuteuil, N., 2008. Catchment, growth point and spatial metaphor: Analysing Derrida's oral discourse on deconstruction. *Metaphor and Gesture*: pp. 171–194.

Murphy, K. M., 2003. Building meaning in interaction: rethinking gesture classifications. *Crossroads of Language, Interaction, and Culture*, Vol. 5: pp. 29–47.

Murphy, K. M., 2005. Collaborative imagining: The interactive use of gestures, talk, and graphic representation in architectural practice. *Semiotica*, Vol. 2005(156): pp. 113–145.

Murphy, K. M., 2012. Gesturecraft: The Manu-facture of Meaning, by Jürgen Streeck. *Journal of Linguistic Anthropology*, Vol. 22(1): pp. 130–132.

Muybridge, E., 1955. *The Human Figure in Motion*. Dover Publications.

Nguyen, N. and Wachsmuth, I., 2011. From body space to interaction space- modeling spatial cooperation for virtual humans. In *Proceedings of the 10th International Conference on Autonomous Agents and Multiagent Systems, AAMAS*. pp. 1047–1054.

Norman, D. A., 1999. Affordance, conventions, and design. *interactions*, Vol. 6(3): pp. 38–43.

Norman, D. A., 2002. *The Design of Everyday Things*. Basic Books.

Núñez, R., 2004. Do real numbers really move? Language, thought, and gesture: The embodied cognitive foundations of mathematics. In *Embodied Artificial Intelligence*. Springer, pp. 54–73.

Núñez, R., 2008. A fresh look at the foundations of mathematics: Gesture and the psychological reality of conceptual metaphor. *Metaphor and gesture*: pp. 93–114.

Ochs, E., Gonzales, P., and Jacoby, S., 1996. When I come down I'm in the domain state: grammar and graphic representation in the interpretive activity of physicists. *Studies in Interactional Sociolinguistics*, Vol. 13: pp. 328–369.

Özyürek, A., 2002. Do speakers design their cospeech gestures for their addressees? The effects of addressee location on representational gestures. *Journal of Memory and Language*, Vol. 46(4): pp. 688–704.

Palmberg, S. and Ranlöf, M., 2002. *A Collaborative VolumeViewer*. Ph.D. thesis, Linköping University.

Parrill, F. and Sweetser, E., 2004. What we mean by meaning: conceptual integration in gesture analysis and transcription. *Gesture*, Vol. 4(2): pp. 197–219.

Patrizio, A. and Kemp, D., 2006. *Anatomy acts: how we come to know ourselves*. Birlinn Publishers.

Pedelty, L. L., 1987. *Gesture in Aphasia*. Ph.D. thesis, University of Chicago, Department of Behavioral Sciences, Committee on Cognition and Communication.

Peirce, C. S., 1998. *The Essential Peirce: Selected philosophical writings*, Vol. 2. Indiana University Press.

Penrose, R., 1971. Applications of negative dimensional tensors. *Combinatorial Mathematics and its Applications*, Vol. 221244.

Penrose, R. and Jorgensen, P. E., 2006. The road to reality: A complete guide to the laws of the universe. *The Mathematical Intelligencer*, Vol. 28(3): pp. 59–61.

Peskin, M. E., Schroeder, D. V., and Martinec, E., 1996. An introduction to quantum field theory. *Physics Today*, Vol. 49: p. 69.

Peto, J., 2007. *The Heart*. Other Distribution.

Pfeiffer, T., 2010. Understanding multimodal deixis with gaze and gesture in conversational interfaces. *PhD, University of Bielefeld*.

Poggi, I., 2002. Symbolic gestures: The case of the Italian gestionary. *Gesture*, Vol. 2(1): pp. 71–98.

Poizner, H., Klima, E., and Bellugi, U., 1990. *What the Hands Reveal about the Brain*. MIT Press.

Pollitt, J. J., 1972. *Art and Experience in Classical Greece*. Cambridge University Press.

Poole, G., 2007. Toto's talking body. *Gesture*, Vol. 7(2): pp. 241–253.

Rahaim, M., 2008. Gesture and melody in Indian vocal music. *Gesture*, Vol. 8(3): pp. 325–347.

Rawson, P., 1987. *Drawing*. University of Pennsylvania Press Philadelphia.

Reason, P. and Bradbury, H., 2001. *Handbook of Action Research: Participative inquiry and practice*. Sage Publications.

Rittel, H. W. and Webber, M. M., 1973. Planning Problems are Wicked. *Polity*, Vol. 4: pp. 155–69.

Rodrigues, I., 2010. Gesture space and gesture choreography in european portuguese and african portuguese interactions: a pilot study of two cases. *Gesture in Embodied Communication and Human-Computer Interaction*: pp. 23–33.

Ruby, J., 1980. Franz Boas and early camera study of behavior. *Kinesics Report*, Vol. 3(1): pp. 6–11.

Ruby, J., 2000. *Picturing Culture: Explorations of film and anthropology*. University of Chicago Press.

Ruskin, J., 1971. The Elements of Drawing (1857). *The Works of John Ruskin, hrsg. von ET Cook und Alexander Wedderburn, Bd*, Vol. 15: pp. 1903–1912.

Sacks, H., Schegloff, E. A., and Jefferson, G., 1974. A simplest systematics for the organization of turn-taking for conversation. *Language*: pp. 696–735.

Sandback, F., Malsch, F., Meyer-Stoll, C., and Liechtenstein, K., 2005. *Fred Sandback*. Hatje Cantz.

Schatzki, T. R., 1996. *Social Practices: A Wittgensteinian approach to human activity and the social*. Cambridge University Press.

Schegloff, E. A. and Sacks, H., 1973. Opening up closings. *Semiotica*, Vol. 8(4): pp. 289–327.

Schneider, A., 2011. Unfinished dialogues: notes toward an alternative history of art and anthropology. *Made to be Seen: Perspectives on the history of visual anthropology, University of Chicago Press*:p. 108.

Schutz, A., 1967. *Phenomenology of the Social World*. Northwestern University Press.

Serres, M., 1995. *Conversations on Science, Culture, and Time: Michel Serres with Bruno Latour*. University of Michigan Press.

Shotter, J., 1993. Bakhtin and Vygotsky: Internalization as a boundary phenomenon. *New Ideas in Psychology*, Vol. 11(3): pp. 379–390.

Shove, E., 2003. Converging conventions of comfort, cleanliness and convenience. *Journal of Consumer Policy*, Vol. 26(4): pp. 395–418.

Shove, E., Pantzar, M., and Watson, M., 2012. *The dynamics of social practice: Everyday life and how it changes*. Sage Publications.

Silverman, D., 2013. *Doing Qualitative Research: A practical handbook*. Sage Publications.

Smith, B., 1995. On drawing lines on a map. In *Spatial Information Theory: A theoretical basis for GIS*. Springer, pp. 475–484.

Smith, B. and Varzi, A. C., 1997. The formal ontology of boundaries. *The Electronic Journal of Analytic Philosophy*, Vol. 5(5).

Smith, B. and Varzi, A. C., 2010. Fiat and bona fide boundaries. *Philosophy and phenomenological research*, Vol. 60(2): pp. 401–420.

Stern, D. G., 1991. Heraclitus' and Wittgenstein's river images: stepping twice into the same river. *The Monist*: pp. 579–604.

Strauss, A. L. and Corbin, J., 1990. *Basics of Qualitative Research: Grounded theory procedures and applications*. Sage Publications.

Streeck, J., 2009. Depicting gestures: Examples of the analysis of embodied communication in the arts of the West. *Gesture*, Vol. 9(1): pp. 1–34.

Streeck, J., Grothues, J., and Villanueva, J., 2009. *Gesturecraft: The manu-facture of meaning*, Vol. 2. John Benjamins Publishing Company.

Sweetser, E. and Sizemore, M., 2008. Personal and interpersonal gesture spaces: Functional contrasts in language and gesture. *Language in the context of use: Cognitive and discourse approaches to language and language learning*: pp. 25–52.

Talbot, W. H. F. and Schaaf, L. J., 1969. *The pencil of nature*. Da Capo Press New York.

Tanaka, S., 2008. The Aspect-Modality Link in Japanese. *Modality-aspect Interfaces: Implications and Typological Solutions, John Benjamins Publishing*, Vol. 79:p. 309.

Tarantino, Q., Travolta, J., Jackson, S. L., Thurman, U., Keitel, H., Roth, T., Avary, R., Rachtman, K., and Sekula, A., 1994. *Pulp fiction*. Faber & Faber, London.

Tashakkori, A. and Teddlie, C., 2010. *Sage Handbook of Mixed Methods in Social & Behavioral Research*. Sage Publications.

Ten Have, P., 2007. *Doing Conversation Analysis*. Sage Publications.

Theron, L., Mitchell, C., and Smith, A., 2011. *Picturing Research: Drawing as visual methodology*. Springer.

Thomas, D. R., 2003. A general inductive approach for qualitative data analysis. *School of Population Health, University of Auckland*.

Tormey, J. and Sawdon, P., 2008. Are ambiguous research outputs undesirable? *Working Papers in Art and Design, University of Hertfordshire*, Vol. 5.

Tufte, E. R. and Graves-Morris, P., 1983a. *Envisioning Information*, Vol. 31. Graphics Press Cheshire, Connecticut.

Tufte, E. R. and Graves-Morris, P., 1983b. *The Visual Display of Quantitative Information*, Vol. 31. Graphics Press Cheshire, Connecticut.

Tversky, B., 2007. Communicating with diagrams and gestures. *Research trends in science, technology, and mathematics education*.

Van Sommers, P., 1984. *Drawing and Cognition: Descriptive and experimental studies of graphic production processes.* Cambridge University Press.

Wilkins, D., 1999. Spatial deixis in Arrernte Speech and Gesture: On the analysis of a species of composite signal as used by a Central Australian Aboriginal group. In *Deixis, Demonstration and Deictic Belief, Proceedings of the 11th European Summer School in Logic, Language and Information (ESSLLI), Utrecht University*. pp. 30–42.

Willis, K. D., Lin, J., Mitani, J., and Igarashi, T., 2010. Spatial sketch: bridging between movement & fabrication. In *Proceedings of the fourth international conference on Tangible, embedded, and embodied interaction*. ACM, pp. 5–12.

Wittgenstein, L., 1967. *Philosophische Untersuchungen-Philosophical Investigations*. Basil Blackwell, Oxford.

Wittgenstein, L., 1969. *On Certainty*. Basil Blackwell, Oxford.

Yoon, C., Thomas, M., and Dreyfus, T., 2009. Gestures and virtual space. In *Proceedings of the 33 rd Conference of the International Group for the Psychology of Mathematics Education*, Vol. 5. pp. 409–416.

Yoon, C., Thomas, M. O., and Dreyfus, T., 2011. Grounded blends and mathematical gesture spaces: developing mathematical understandings via gestures. *Educational Studies in Mathematics*, Vol. 78(3): pp. 371–393.

Young, K., 2002. The dream body in somatic psychology: The kinaesthetics of gesture. *Gesture*, Vol. 2(1): pp. 45–70.

Zahrádka, J., 2011. Morgan O'Hara: Záznamy. *CZE, Památník Leoše Janáčka, Brno*, Vol. 20.

Appendix A

Glossary

Short definitions of selected terms are given below as a general guide to working assumptions behind this thesis.

A.0.2.5 Qualitative space

The spaces that have been expressly linked with the content of utterances, such as topic spaces. Including but not limited to those spaces that are distinctively shared. This thesis has focused on the latter type of qualitative space, but the discussion of shared space is conditioned by the processes within interaction that lead to the 'joining' of the qualitative spaces of individuals, as described by Heidegger.

A.0.2.6 Camera lucida

The *camera lucida* performs an optical superimposition of the subject being viewed upon the surface upon which the artist is drawing. The artist sees both scene and drawing surface simultaneously, as in a photographic double exposure. This allows the artist to duplicate key points of the scene on the drawing surface, thus aiding in the accurate rendering of perspective. At times, the artist can even trace the outlines of objects.

A.0.2.7 Contrast boundaries

Contrast boundaries is a term used in life-drawing classes to indicate the boundaries between light and dark shapes, within a drawing for example. In this thesis, the term is used for the spatial and temporal boundaries of segments of human interaction, with special regard to spaces that are shared and those that are not directly used as a resource for communication. In this way, contrast boundaries are concerned with the visual representation of spaces that have been brought into the collaboration of the architects as a resource for communication.

Other terms have been used by analysts of human interaction to convey similar types of separations, for example where the ‘phase boundaries’ of an occurrence have been discussed, or where the temporal and spatial ‘horizons’ of a single phenomenon are the unit of analysis.

A.0.2.8 Constructivism and Grounded Theory

Constructivist grounded theory typically deploys criteria such as credibility, usefulness, and resonance within analytic categories that are grounded within the data under study. Validation or authenticity criteria fall into four main types: ontological, (and epistemological), educative, catalytic (related to whether change is introduced as result of the research), and tactical (or methodological). Grounded theory has been described as: ‘a largely inductive method of developing theory through close-up contact with the empirical world’ (Denzin and Lincoln, 2005, p.383).

A.0.2.9 Participatory Action Research

Denzin and Lincoln defines Action Research as ‘a movement in which researchers work with subordinated populations around the world to solve unique local problems with local funds of knowledge’ (Denzin and Lincoln, 2005, p.386).

Participatory techniques have emerged as a primary means of gaining access to hard-to-reach data. The approach was founded by Robert Chambers as: ‘a growing family of approaches, methods, attitudes and behaviours to enable and empower people to share, analyse, and enhance their knowledge of life and conditions, and to plan, act, and monitor and evaluate’. [1]

[1] http://www.dwml.net/words/notes.htm

A.0.2.10 Topic

Topic is generally understood to be the subject of discussion, meaning a discourse or conversation, or a matter dealt with in a text. This word comes from the Greek *topos*, meaning 'a place. In linguistic terms, a topic is typically the first major constituent of a sentence.

A.0.2.11 Topical space

Defined in this thesis as a space that has been differentiated by its relationship to a topic within an interaction. This is theoretical concept, with no commonly agreed definition. It is an abstraction from individual instances of topics as referred to in human interaction by using real space as a resource to invoke the topic. The notion of 'topic space' is aimed at raising the possibility of an analysis that connects these separate spaces or draws a contrast between them in some way. 'Topic space' is therefore one or more regions of interactional space referred to by one or more speakers when they refer to a topic. (Also see Sect. 3.2.1.1). Topic spaces can therefore broadly be defined as regions of involvements that are defined by our practical concerns, and it is through these regions that we encounter others.

A.0.2.12 Gesture

Gesture is commonly understood to relate to any movement that has a significant import in human behaviour, usually referring to any kind of bodily movement that has a bearing on the discourse, whether this is acknowledged in the behaviour and speech of addressees or not. The word has its origin in medieval Latin *gestura*, from Latin *gerere* 'bear, wield, perform.' Gesture was first used with regard to oratory and the 'bearing', or 'deportment' of speakers.

A.0.2.13 Time-series

Please see below.

A.0.2.14 Small multiple

Small multiple is a term coined by Tufte to describe representations that contain several separate panels, which are used to present an analysis for each phase of an event or interaction. The number of these panels or sub-parts ca vary greatly, and can be adapted to convey time and sequencing in any number of ways. They are in use in many disciplines including those that study human interaction. They are also sometimes referred to as ‘time-series.’

> An especially effective device for enhancing the explanatory power of time series displays is to add spatial dimensions to the design of the graphic, so that the data are moving over space (in two or three dimensions) as well as over time - three excellent space-time story graphics illustrate here how multivariate complexity can be subtly integrated into graphical architecture, integrated so gently and unobtrusively that viewers are hardly aware that they are looking into a world of four or five dimensions. (Tufte and Graves-Morris (1983b), p.40).

A.0.2.15 Data-ink

Tufte coins the term ‘data-ink’ to refer to the that used for the presentation of data. Non-essential data-ink should be removed from the representation, without loss to the graphical content. Non-data-ink is thus that which does not convey information but is used for scales, labels and other framing devices. The data-ink ratio is the proportion of visible ‘ink’ that is used to present data compared to the total amount of ink (or pixels) used in the whole representation.

A.0.2.16 Catchment

Catchment is a proposed analytic concept to describe phenomena that pattern discourse. This is ‘a kind of thread of visuospatial imagery that runs through a discourse to reveal the larger discourse units that encompass the otherwise separate parts’, and it is possible that several clearly identifiable ‘gesture features’ run through a discourse and unify it. These features link back into each other to form a set at a higher level of analysis, which enables the concept to be used as a notation in formally coded observations of speakers. Repetition according to McNeill is a key feature of catchment. They are often noticeably pictorial and spatial against a background of many different kinds of acts, of mixed drawing and pointing for example, and they stand out because of their emphasised invocation of a spectatorial point of view.

A.0.2.17 Interactional topology

A topology of interaction is a concept developed to account for observations of turn-taking, joint focus of attention, and spatio-temporally dispersed contributions. These include but are not limited to virtual gestural maquettes, implemented jointly by participants, and topic space more generally. The notion is designed to convey the heterogeneity of modalities that may be operation. As for example in the case of gestural maquettes that integrate two drawings into a single representational space for that moment. In the context of the theory of social practice a related concept is that of the 'space-time manifold' of practice.

'Maquette' is the French word for scale model, sometimes referred to by the Italian names 'plastico' or 'modello.' It is a small-scale model or rough draft of an unfinished architectural work or sculpture. An equivalent term is 'bozzetto', from the Italian word for 'sketch.'

A.0.2.18 Gesture-completion

Please see below.

A.0.2.19 Gesture-extension

A development upon, rather than simply a completion of an unfinished gesture, or a completion of one that invites a responding gesture. Turns 19-20 of the data excerpt are examples of gesture-extension. This has an important role in the creation of shared spaces that were observed in the case study, where colleagues have added entirely new information and fresh thematic development into previously established topical space, using gesture and speech. The notion of gesture extension is aimed at the creation of unifying catchment points as a joint activity.

A.0.2.20 Cohesives

Gestures that are part of a 'cohesive chain', contributing to the discourse as a unified entity. McNeill states that 'cohesives' are gestures that bind the discourse across space and time, and are 'thematically related but temporally separated', consisting of iconic, metaphoric, or pointing gestures. Thematic patterning produced by cohesives contribute a poetic dimension that performatively unifies the discourse.

A.0.2.21 Gesture space

There is no single concise and agreed definition of what constitutes gesture space. The term is used in different senses by several writers. Sometimes described in experimental settings as 'a shallow disk in front of the speaker.' The term seems to have been instantiated by Pedelty in discussion of aphasia, as a way of distinguishing normal from abnormal usages of gesture in communication (Pedelty, 1987).

Gesture space is sometimes treated as a schema for organising observations of the distribution of gestures in space around the speaker. At other times the term is used to identify qualitative spaces generated during interaction, as more of a description of where gestures have originated from and what they refer to, resulting in a multiplicity of gesture spaces that are shifted between during an interaction.

A.0.2.22 Deixis

Commonly used as a term for the range of pointing gestures that index space and link it to speech. In linguistics, deixis refers to the phenomenon wherein our understanding of the meaning of certain words and phrases in an utterance, requires essential and specific contextual information. Words are said to be deictic in their use if their semantic meaning is fixed but their denotational meaning varies depending on time and/or place.

A.0.2.23 Origo

A contested theoretical notion, sometimes also referred to as the 'deictic centre', designed to 'anchor' deictic expressions in their physical context. The 'origo' is one or more originating points that an analysis can use to lead to the relevant part of the setting. In 'deictic systems', goes the argument, the origo 'identifies with the current speaker (or some property thereof)' (Tanaka, 2008). In this view, when architect C, says 'This is my silencer' (Clip 1), the deictic sense of the word 'my' in this context would be dependent on the origo, with C. In relation to the act of pointing, the referent is pointed to by the head of an arrow, while the origo would be the tail of the arrow, pointing back to its place of origin.

Appendix B

The full extract transcript, including video frames

T1. A: ((*points with pen ss1,3*)) that door/ all the way through there
T2. A: ((*continues drawing, ss1*)) you can drop the door / so that youve got (1.0) that zone there / is all open and free // ((*looks at D*))

T3. B: oh yeah
T4. A: yeah? //
T5. A: so th-thats just all air // ((*points ss1*)

T6. D: uhum /
T7. C: yeah
T8. A: ((*drawing with red pen in ss1*)) and then somehow / youve got a // I was having the door be up to that level / but / at the moment we got //
T9. A: the canopy is in that ((*points ss1*))zone // yeah?
T10. D: mm
T11. A: / you can drop the door (0.5) you have got that zone there / but its going to have to be louvered //((*draws horizontal lines to show louvers, ss1*)) [above the]-

T12. C: [w]-what does the elevation of that door look like / if you were looking at the door? ((*hovers and points repeatedly with pen towards ss3*))

Figure B.1: Transcript, with video frames, part 1.

T13. A: Umm / this is the first time its been drawn // as we speak ((*drawing with red pen, ss1*))
T14. A: ((*points and continues to draw is ss1*)) so that thats that will louver / that that thats the crinkle-crankle/ zinc / and thats the door ((*points*)) /
T15. A: well/ but its actually going behind there b-b th-the doors there ((*draws rectangle in ss1*)) / say like that ((*continues drawing in ss1*)) // handle ((draws handle))
T16. A: s-so im im drawing that bit of louver there ((*draws, ss1*))/ for/ your benefit (0.3)

T17. A: so but you're always its always gonna be a louver isnt it? /
T18. B: ((*points with pen, ss1, 3*)) thats not great because
T19. C: [Hmm]
T20. B: [thats / the / ((*moves away from ss1 towards ss3 but back again before reaching it*)) opening over the door [is actually here] //

T21. D: [you've got that as well] ((*points while moving his finger along axis, ss1*))
T22. A: youve got that above it, yeah / ((*points and draws, ss1*))

Figure B.2: Transcript, with video frames, part 2.

T23. D: for that whole width? / ((*indicates, ss1,2*))
T24. A: yes
T25. D: so you got that/ ((points, ss1)) plus that ((*points, ss2*)) Bill / (to bring cover the free air) /
T26. D: [Its not enough]

T27. B: [w-whats wrong] with the what Kevins proposing to actually if you pulled out that whole of that / w/hole / theres / the whole of that portion youre actually letting in // and we / we re-engineer this corner / ((*while drawing in ss3*))
T28. B: I mean c - if we went back down to columns ////
T29. D:mmmm
T30. B: well in this corner/ it started as a f-five hundred by five hundred diameter column / so if it was a bit smaller? / ((*points to ss3*))
T31. A: uhum /////
T32. C: ((*points with pen towards ss1 drawing by A*)) how high is this again? /

T33. C: from the ground to //
T34. C: ((*points with pen at point Z in ss3*)) f-f-from standing in/ standing at that point there //
T35. D: yeah/
T36. C: to//soffit/

Figure B.3: Transcript, with video frames, part 3.

T37. D: two one nine seven /
T38. D: two nine one seven / plus four fifty
T39. C: two nine one seven? /
T40. D: yeh (15.0) ((*A continues with s4 drawing in front of him*))
T41. C: hmm ////
T42. D: almost///////
T43. C: I think that looks great /

T44. A: (*laughs*) /
T45. A: w-w-which bit / tha-tha this whole thing as a kind of air scoop? ((*rapidly indicates with circling motion the area above ss1, with hand and pen in a similar area to that of B gesture at Turn 18 above*)) /

T46. C: yeah / mean what I was thinking was / if its two nine one seven right? /
T47. A: uhuM
T48. C: plus four fifty / whas the four fifty?
T49. D: thats the depth of the beam ((*while looking at drawing in SS1 and underneath*))
T50. C: oh ok / plus four fifty /// its about three point three yeah? ((*writes in between ss1 and ss3*)) // then my silencer / is nine hundred and sixty high ((*pointing at ss4*))

Figure B.4: Transcript, with video frames, part 4.

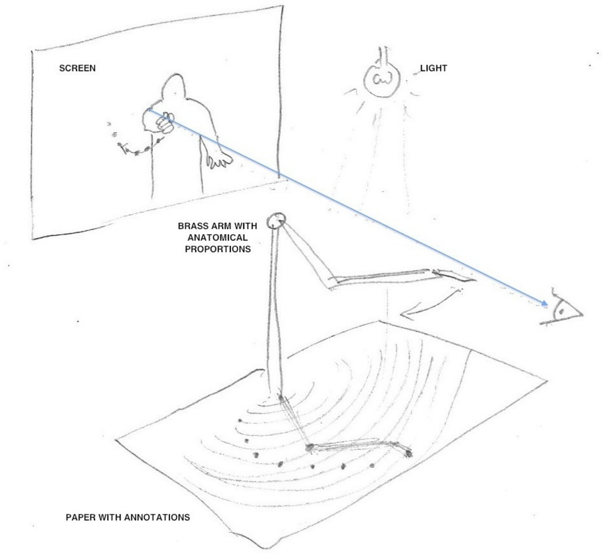
Appendix C

Efron: Drawing from fore-shortened film footage

An extended passage quoted from Efron is included for the reader's reference (Efron, (1941), p.69-70). It reveals a scenario where difficult-to-obtain results were extracted from filmed data. Severe perspective fore-shortening was mitigated by modelling the movements with a sculptural armature. This was a technique designed to extract details of gesture space usage in otherwise unusable footage, and to assess the accuracy of previous 'visual estimates':

> A more practical method has been devised lately for the calculation of gestural foreshortening. It amounts to a mechanical replica of the trigonometrical 'arm', which permits reproduction in the third dimension of the two-dimensional curves of the graphs, therefore making possible a reading of the actual radius in each case. It consists of a square wooden base, to the centre of which is attached a jointed and rotating brass 'arm', the upper and for parts of which are extensible. The graph is affixed on this base in such a way that the centre of the latter [the base] coincides with the *manubrium* of the gesturer. A light bulb suspended directly over the centre of the base causes a shadow reproduction of the attached arm to fall on the graph. Both the upper and forearm are extended (or retracted as the case may be) in order that the elbow and wrist points in the shadow coincide with the same points on the

graph. By moving the arm in this way from one frame to another, a three-dimensional measure of the foreshortened movement is obtained. Several graphs have already been studied by this procedure. So far the results indicate that the errors in our visual estimate are slight.



Appendix D

Representing interaction: a taxonomy of graphic techniques

Arrowing, Ribboning, and Layering.

Each of the sections that relate to each of the main themes, have a listing of graphic properties found in the literature, in chronological order of their making. This listing of properties is followed by selected images of these examples from the literature. Since these images very often contain the authors' captions and annotations.

The listings of graphic devices are given by type and then by their chronology within this type. No organised attempt has been made to apply the criteria of increasing simplicity in representations, although it is possible to see a general trend of this kind over time. This can be seen if comparing the visualisations and transcripts of Efron to Kendon, of Kendon to McNeill, and of McNeill to Streeck (Efron, 1941; Kendon, 1980; McNeill, 1992; Streeck, 2009).

1. **Movement: pointing vector extended:**
   Pfieffer, 2011,showing a line extending outwards from the pointing arm.

2. **Movement: increments: later stages displaced from main figure:**
   Efron, 1941, four stages of movement are shown, including excerpts from transcript below. The shoulders are redrawn in each instance, slightly reduced in size from the first one. Dotted arrows are used for the direction of the movement, and their weight is useful in determining the level and

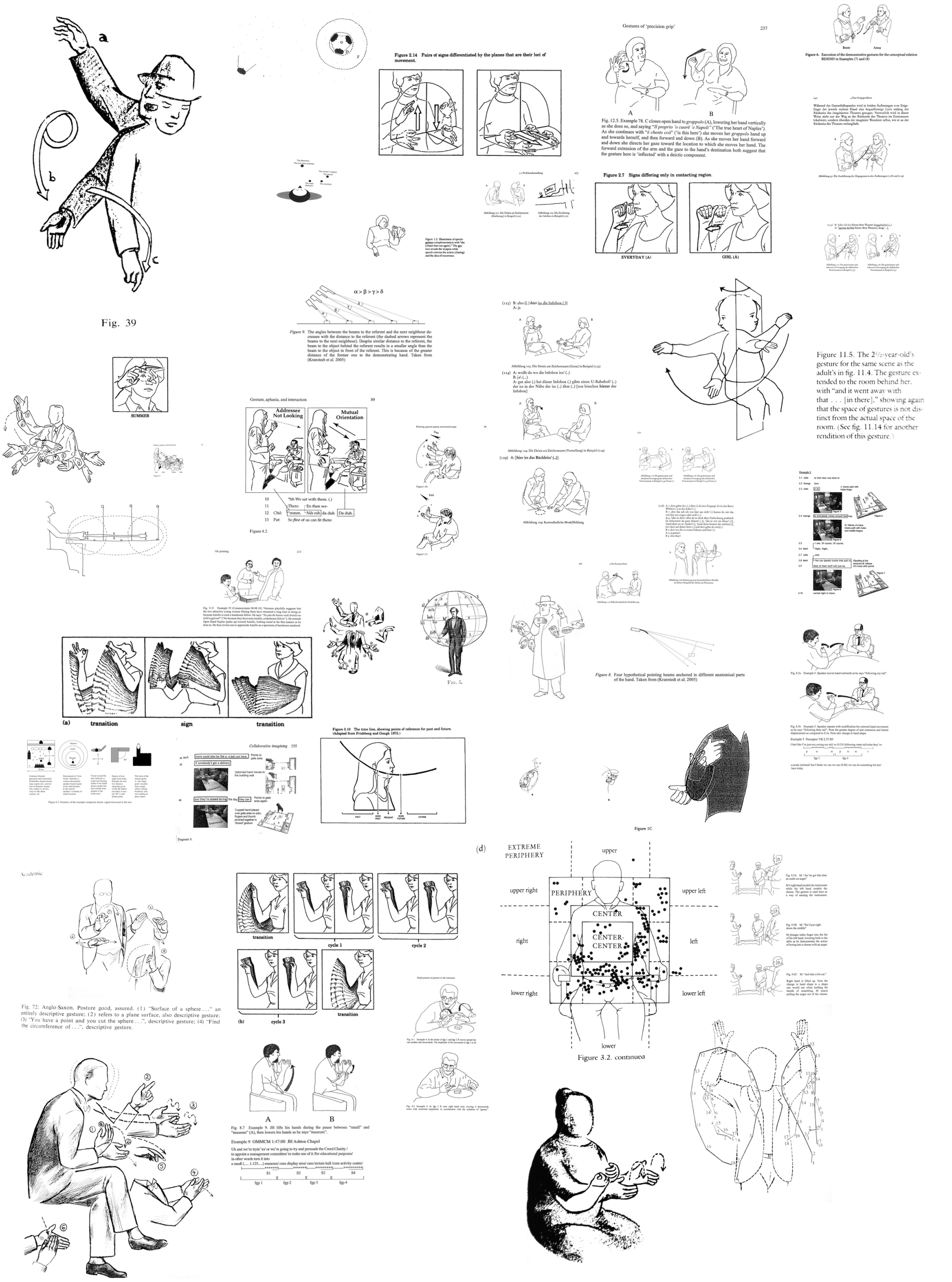


Figure D.1: A collage of drawings of gesture and interaction from the literature, indicating the variety of drawing techniques from 1941 to the present day.

type of activity, that seems measured and calm. The arrows are in contrast with the figure that is drawn with solid lines.

Efron, 1941, six stages are shown in side-view, all of which in the frontal centre space. The figure is drawn in ink with shading, while the face is shown only in a single line profile. Small dashes are used to construct the arrows, and also for some back-and-forth head movement. Larger dashes are used to layer later stages of arm movement beneath the earlier ones.

Efron, 1941, nine stages shown, unfolding from centre space, with paired simple solid-line arrows, drawn in a similar weight to those of the main figure. No shading is used in this image. (See gesture space visualisations for this example).

3. **Movement: increments: new vantage point:**

   Efron, 1941, a hand-wave motion, shown as part of series of gesture phrases, but in this case it is seen from different side. This is in order to emphasise the undulations of the movement, and also to overcome the obstacle that the original perspective is unsuitable for representing this hand-waving gesture. The new vantage point is a re-imagining of the gesture, as it would be seen from another point of view. (See gesture space visualisations for this example).

4. **Movement: increments: over- and under-lying paths: last over-lying first:**

   Efron, 1941, simple paths knotted.

   Efron, 1941, includes shading of earlier underlying stages a and b, while the last increment is not to the same extent. Arrows are unshaded ribbons that curving over themselves and show the looping movement of stages a to b, and the continuing downward movement of stage c. The ribbons effectively convey the way in which the hand twists but the highest point, a, is not connected to the arrowing.

5. **Movement: solid, not arrowed lines or paths:**

   Efron, 1941, both arms loop as paths of solid lines, for wrist and elbow as separate mappings. Each is numbered according to frame increments, while the body is ghosted (reduced to a visually understated presence) due to the use of predominantly dashed lines. Only one stage of movement is shown in this way. Following the vectors of the wrists and elbows from their starting positions tells us that at least one of the elbows was slightly raised during the early moments of the raising of the arms, but there is some difficulty in determining depth information from these vectors.

6. **Movement: dashed zones:**

   Fricke, 2003, a dashed-line in an elliptical geometric shape. The top of the shape touches the lower part of the hand of an extended pointing arm. This may be intended to be the part of the moving hand that is tracked by the dashed ellipsis, indicating the region where the arm waves during the gesture. From the drawing alone it is not possible to determine if this elliptical shape represents an actual arm movement vector, or if it shows an abstracted range of movement as a summarisation. The figures are drawn in solid line.

7. **Movement: dashed lines:**

   Efron, 1941, hand and elbow increments are shown in dashed form without being arrowed, frame by numbered frame, and the same for the later series of head movements. Vectors for wrist and elbow become somewhat entangled and so are themselves identified with arrows. To extricate the drawing from this graphic confusion a same-size ribboned vector is drawn, interestingly, from a slightly different perspective.

8. **Movement: filled arrows:**

   Wilkins, 1999, Australian Arrente study, illustration showing a pointing 'horned hand' gesture. With filled arrow shown in a vanishing perspective.

   Kendon, 2004, filled arrow as part of sequence of unframed images.

   Kendon, 2004, using filled and heavily drawn arrows whose lengths are tapered towards the tip, to show the direction of the gesture and its progression. The size of arrow seems to be related to the overall size of the gestural movement. This is slightly confusing if this diminution is not meant to indicate a movement away from us. (See Movement: increments for earlier moment: dotted outlines).

   Kendon, 2004, use of filled arrow, the first part of which is the thicker ribbon of a tapered arrow, and the second part of which is thinner pointed end. The arrow is semi-shaded at the beginning and solid (inked black) at its end. This may be to indicate that the looping vector is revealed as the underside of the ribbon as semi-shaded, implying that its topside is solid black in colour. The effect is to show the small twist in hand movement toward the speakers mouth and face. This is complemented by the first stage of hand and arm movement being dashed in line, that shows the grasping action of the hands. Also illustrates how arrows are often used by Kendon and others alongside the hand, so to speak, to show the general trend in movement rather than to indicate the actual hand position.

9. **Movement: unfilled arrows: bold:**

   Klima and Bellugi, 1979, sign-language denoting Summer, the arrow is tapered and rendered in bold against the finer lines of the figure.

   Klima and Bellugi, 1979, segmented gesture phrase.

10. **Movement: semi-filled arrows:**

    Kendon, 2004, uses unfilled arrow heads, apparently intended to keep other nearby details visible, e.g; the dotted fingers of the right hand. Perhaps also to suggest a reduced ‘amplitude’ as per the captioning, and to suggest the gestural turning action, as if the arrow had two sides/edges of different colours.

11. **Movement: lined arrows:**

    Bavelas, 1992, with simple two-stage overlapping.

    Bavelas, 1995, the same gesture is pictured, but now with tonal values added, and clearer incremental stages demarcated.

    Bavelas, 2007, mans’ gesture describing how a dress is trimmed, made while moving over his body. Simple arrows in white over the video still frame, added post production in a pixel-based image manipulation application. These may have been drawn with a mouse or a Wacom pen tablet, and are effective at showing the direction of movement but are distinctly clumsy in relation to showing the nuances of hand movements in peripersonal space.

12. **Movement: broken arrows:**

    Kurbel, 1941, a circling hand motion, shown in overlapping loosely drawn broken and lined arrows, (reproduced in Efron, 1941, but earlier).

13. **Movement: dashed arrows:**

    Efron, 1941, drawing of woman performing a double-handed forward jump gesture, shown in two stages, with small dashed forward-moving arrows.

14. **Movement: transparent tapered arrows:**

    Kendon, 2004, transparent tapered arrows side by side to illustrate the ”reams” co-speech gesture, presumably to allow view of the figure beyond. Also includes a small dotted outline of a directional arrow to accompany a similarly dotted hand in its gesture-preparation phase. The dotted line is therefore equivalent to the early phase, and less prominent than the main stroke. His arrows being side-by-side do not imply that the two strokes were spaced slightly apart spatially, but instead this a work-around graphic strategy in order to show that the two strokes were in fact in the very same location but distinct repetitions.

15. **Movement: ribboned arrows:**

    Efron, 1941, man with hat moves his head and arm through three stages, and 2 dimensional ribbons interconnect these.

    Efron, 1941, man with hat, two stages, single ribbon, quite ambiguous in terms of depth information that is given.

    Efron, 1941, shown separately as ‘pattern of movement’, and shaded.

    Efron, 1941, shows ribbon, with the head at the beginning of the vector, and also with the frame number inscribed with the head, while at the end of the arrow there is a maltese cross shape that is also numbered with the last frame number (30). These shapes are also shown on the more detailed versions that are above.

    Kendon, 2004, use of ribboned arrow, shaded to show the twisting effect desired or the rotation of the hand.

16. **Movement: increments: ghosting:**

    McNeill, 1992, clip for ‘bends it way back’ shows three stages of arm upswing.

    McNeill, 1992, start position is indicated via the heavier pen line that is used for the moving arm, while the two later stages shown are in slightly lighter mark. Simple unweighted and non-tapered lined arrows indicate the direction of movement. This is used in place of the ‘last over-lying first’ graphic strategy. The difference between this and the use of dotted outlines to show earlier phases of movement, is that this ‘ghosting’ effect makes no attempt at abstracting or reducing parts of the outlines of the limb.

    Pfieffer, 2011, 3d rendered results superimposed and amassed, where the use of transparency in notating the gestures is intended to convey duration of the movement and presence of other instances rather than to be able to see the table or figure beyond..

17. **Movement: increments: earlier moment of gesture phrase: dotted outlines:**

Fricke, 2003, dotted outlines for the arm is used for the earlier moment of the gesture of Beate (B), but not for her companion Anna (A). This is combined with lined arrows to show direction. Note the use of un-dashed lines for the uplifted hand, whereas the arm below is dashed.

- Another version same gesture from a different publication. The same arrows are used, different in length however. The dotted arm is taken from a different slightly later video frame, and in this case it is clear that the current version of the diagram has been traced from the first version. This can be seen in the hesitancy and broken way in which the outlines of the figures have been drawn.
- Yet another version same gesture, this time separated into a pair of figures (that are not panelled). This may have been made at the same time as the second version, as the lines within the drawing are very similar. The alternative arrows used in this version may have been added through a package such as Photoshop where it is possible to work with layered documents, keeping the basic outlines intact as a foundation, and using transparent layers above this to create simple arrows. which makes them seem less like a synchronous gesture.

18. **Movement: increments: later moment of gesture phrase: dotted outlines:**

Kendon, 2004, an interview scene where lines of fine dots are used in conjunction with arrows to show the later phases of arm movements. The drawing is intended to show the build-up to a series of repeated emphasis gestures, as is seen in the accompanying transcript. This pair of drawings serves to illustrate a pragmatic point about the way in which they are made: when tracing from frame-grab A, the right knee of the addressee is visible, and when tracing from frame B it is not. Hence dotted lines will be used as a default action to avoid the confusing superimposition of solid lines. If Kendon had traced the last frame first he could have used solid lines for the gesturing arm and dotted lines for the earlier frame. In his caption, Kendon draws our attention to the greater degree of lateral displacement in the second drawing. It is noticeable that this arrow is thinner and more elongated than its counterpart in the drawing above. Arrows are therefore seemingly intended to convey these types of nuances. (See my re-drawing).

Kendon, 2004, another example of the so-called precision grip (or 'grappolo'), this time represented using adjacent images. Each image shows one part of a gesture unit. This image exhibits a mixed use of conventions that is of interest in that it illustrates the degree of flexibility with which these conventions are used, in this case by Kendon. Here dotted outlines are used for the later parts of gesture phrase (on the left), and then dotted outlines for earlier parts of gesture phrase (on the right). This would seem to be a means of connecting the two panels temporally and in terms of the depicted motion, allowing the eye to track where the hands are drawn in solid lines and establish a temporal sequence. Solid lines are therefore in place at the beginning and the end of the gesture phrase. The emphatically tapered arrow on the right side is not meant to indicate a movement away from our viewpoint, but is a way of sowing that the narrow tip is the most recent point in time. In this sense, the arrow might be compared to vapour trails from aircraft, the longer it remains in the sky the more widely diffused they become.

19. **Movement: coarse forward differencing:**

    Bavelas, 1992, line drawing showing circling movement, three stages of movement shown, (coarse forward differencing, as I have called this) with finely drawn circling arrows that are semi-broken (or badly reproduced).

    Bavelas, 1995, same gesture from a later publication, with shading to differentiate different stages of movement from each other, and without the arrows used in the earlier version of the graphic.

20. **Movement: fine forward differencing:**

    Haviland, 2000, 2003, four stages of an arm swinging out are shown, subsequent states are shown 'under' the former ones.

    Klima and Bellugi, 1979, segmented gesture phrase in three separate stages, without the cycles.

    Klima and Bellugi, 1979, segmented signing gesture phrase, including preparation and retraction phases (or 'transitions' and 'cycle' numbers 1-3.) There are up to 20 forward differencing stages shown, following the number of frames captured, which give a strong impression of the speed and momentum of the gestural movements.

21. **Movement: preparation, stroke, and retraction:**

    McNeill and Pedelty, 1995, with transcript identifying these stages.

    Kendon, 2004, as part of associated transcript. See example given above from Kendon, where the phases are distinguished in the transcript using a variety of typographical symbols that are separated by forward slashes.

Appendix E

Criteria for modelling theoretical gesture space

This Appendix presents a number of example of hand-made drawings that are derived from and informed by the multi-dimensional drawings (Figs.5.22, 5.19, 5.20, 5.21, 5.24, and 5.25). [1] This was derived from repositioning a number of copies of the gesture space model to approximate the bodily relationships of the architects at certain points within the interaction. the shape of the model represents the ways in which the arms pivot from the shoulders, and reach forwards, creating single shape from their superimposed separate arcs. The model also represents in a schematic way the backwards reach zone as well as the forward reach zone.

The initial digital drawings that were based upon Clip 1, were aimed at testing whether existing theoretical models of gesture space were able to provide a good basis for visualising the spaces of interaction. Kendon's schema was singled out for this purpose, because of the level of detail provided, and the organisational subdivision of interactional spaces into functionally differentiated zones (Ciolek and Kendon (1980), and Kendon (1990)). The drawings are realisations of how theoretical individual gesture space models of each of the architects intersect and overlap with one another. This is one approach to visualising shared space with body-centric

[1] Some of the material here has been previously published as 'Making Space for Interaction', Gesture Workshop 2011 (Heath and Healey (2011))

terms of reference.

These studies set out to examine whether this schema can satisfactorily describe micro-articulations within the central *o-space*. The drawings showing the architect's interpersonal *gesture-space-overlaps*. These are spaces that are implied by Kendon's theoretical notion of *transactional segments*, plus the invoking of a pivotal point for an individual gesture space (the manubrium), and *F-formations*. They attempt to show these manipulations of topical subspaces within the interaction.

Criteria used in designing the gesture space model:

1. The manubrium: a central and easily identified anatomical marking point which acts as a starting point for placement of the gesture space (the manubrium is sometimes denoted with a upside-down cone in the modelling). This is a criterion used by David McNeill in Hand and Mind, McNeill (1992).

2. Average arm dimensions, to achieve a span of approximately 170 cms. An average reach was measured in directions from the *manubrium*. Modelled to actual size.

3. A 30 degree *transactional segment*, conceived as a projected down two-dimensional schema with which to organise the data. here plotted within the gesture space models limits. This denotes the forward-facing zone of attention of a person. The overlaps of this segment with the segments of other people produce areas of jointly maintained interest and activity, or an *o-space*.

4. An upright axis to denote postural axis following the spine.

5. Added to this, an orthogonal axis which follows the approximate alignment of the shoulders.

6. Finally, these are reduced visually to outlines of the volume.

Figure E.1: The *manubrium*.

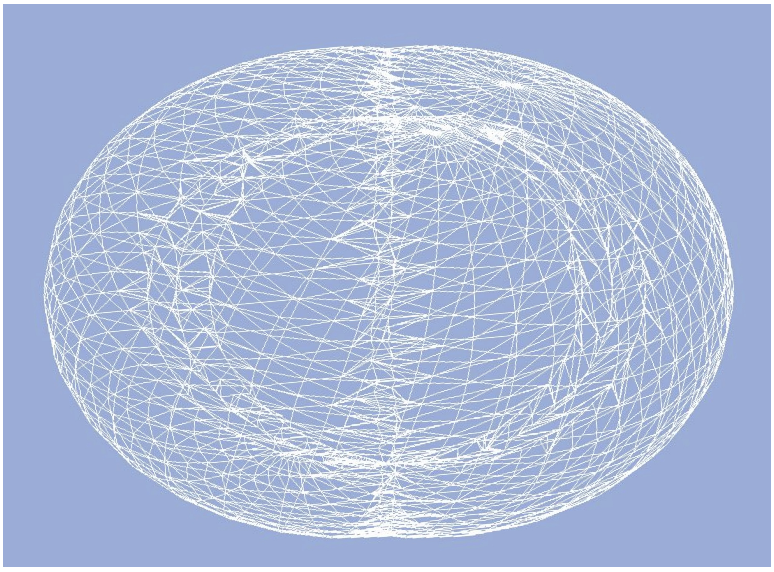


Figure E.2: The *gesture space model* seen in elevation, frontally.

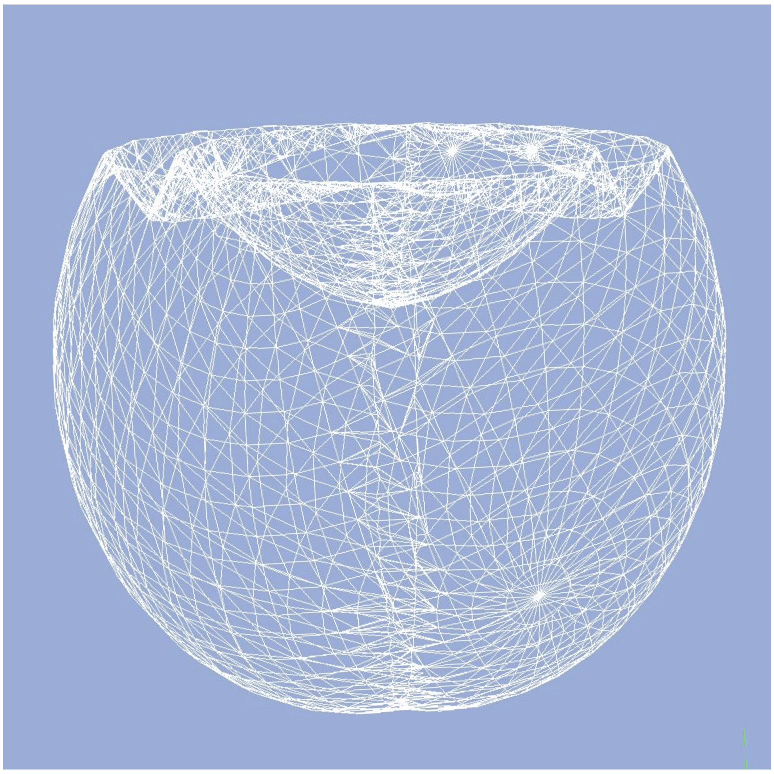


Figure E.3: The digital gesture space model seen in plan. The *manubrium* is located in the centre.

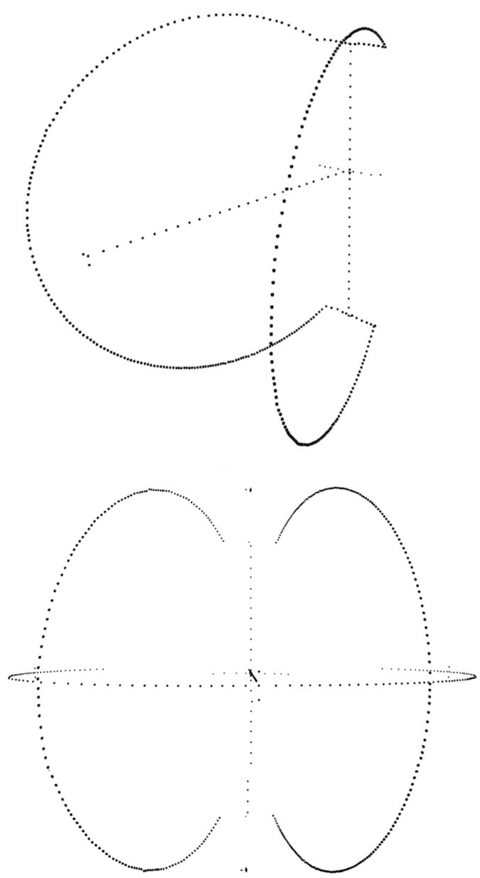


Figure E.4: Two views of reduced versions of the schema that was modelled with the multi-dimensional drawing tool *Cloud 9*. The overall shape is represented by markers placed around the model along critical horizontal and vertical axes.

Appendix F

Screen-shots from participant's data

Samples of screenshots of quicktime movies are given here, taken from the drawings workshops participant's data that was drawn. This shows the wide variety of data that was treated.

Figure F.1: CG movie, 'Alex left hand circle.'

Figure F.2: PB movie.

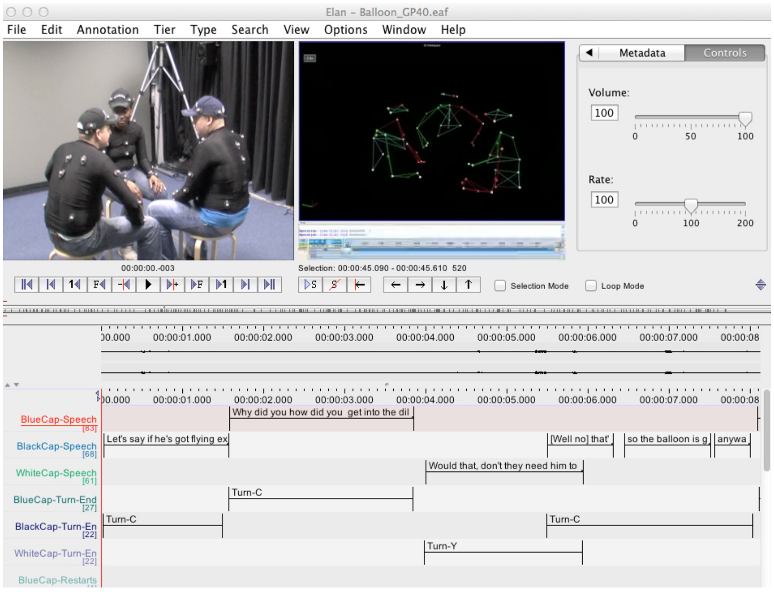


Figure F.3: ML movie.

Figure F.4: ML movie.

Figure F.5: IB movie.